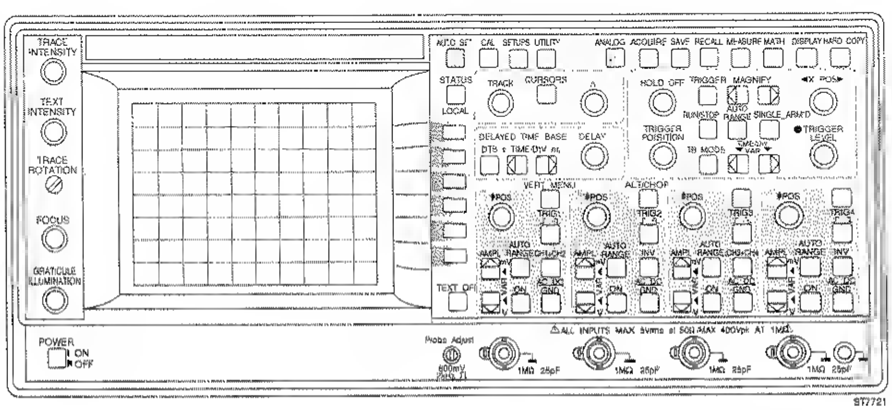
Autoranging CombiScope™ Instrument

PM3370A-PM3380A-PM3390A
PM3382A-PM3384A-PM3392A-PM3394A

SCPI Users Manual — *950601*



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1 ABOUT THIS MANUAL

The SCPI Programming Manual for the CombiScope™ instruments describes how to program your CombiScope™ instrument via the IEEE bus using SCPI commands.

1.1 What this Manual Contains

A complete table of contents is given at the beginning of the manual.

Chapter 1	ABOUT THIS MANUAL Explains what the SCPI programming manual for the CombiScopes instruments contains.
Chapter 2	GETTING STARTED WITH SCPI PROGRAMMING Tells you how to get started quickly with your CombiScope instrument. You can execute the program examples per (sub)section or from the beginning until the end.
Chapter 3	USING THE COMBISCOPE INSTRUMENTS Explains how SCPI works for your CombiScope instrument from the functional point of view. Section 3.1 is an introduction and section 3.2 explains the fundamental programming concepts. The other sections and subsections represent the functional use of your CombiScope instrument.
Chapter 4	COMMAND REFERENCE Is a complete alphabetical reference of all implemented SCPI commands. In the beginning a command summary is given to provide you with a quick reference.

Appendix A APPLICATION PROGRAM EXAMPLES
Appendix A describes some application program examples. The application programs are supplied on floppy.

Appendix B CROSS REFERENCES
Appendix B gives cross references between SCPI commands and front panel keys, softkey menu options, and instrument functions.

Appendix C MANUAL CONVENTIONS
Appendix C explains which abbreviations and symbols are used in the manual. It also gives a list of the tables, figures, and documents referenced.

Appendix D STANDARDS INFORMATION
Appendix D gives information regarding SCPI and IEEE-488.2 standards.

Appendix E SUMMARY OF SYSTEM SETTINGS
Appendix E lists the system settings per functional group (node), plus the applicable instrument settings per node.

A full alphabetical index is given at the end of the manual.

2 GETTING STARTED WITH SCPI PROGRAMMING

2.1 Preparations for SCPI Programming

To program your CombiScope instrument, you need a system setup and a programming environment. Various program examples (refer to PROGRAM EXAMPLE:) are given in the following sections. These program examples can be executed one at a time or chained together for a complete tutorial. The program examples are based on the system and programming environment as described below.

Note: *All PROGRAM EXAMPLE's in this chapter are supplied on floppy under the file name EXGETSTA.BAS. They are chained together in order of appearance.*

2.1.1 System setup

- The CombiScope instrument contains a factory-installed IEEE option.
- A PC is used as controller. In the PC an IEEE-488.2 interface (GPIB) board must be installed to turn the PC into a GPIB controller. The GPIB controller must be connected to the CombiScope instrument via an IEEE cable.
  Note: *The program examples throughout this manual have been executed on an IBM-compatible PC with the GPIB interface board and software of the product PM2201/03 installed. The PM2201 board is equivalent to the PCIIA board from National Instruments.*

2.1.2 Programming environment

- MS-QuickBASIC is used as the programming language.
- A number of standard IEEE-488.2 drivers are used to control the CombiScope instrument via the GPIB. These drivers must be included in the application program. Therefore, the first statement of an application program must be as follows:

```
REM $INCLUDE: '<path>QBDECL.BAS'
```

  Note: *The program examples throughout this manual have been executed using the IEEE-488.2 drivers and the device handler GPIB.COM of the product PM2201/03.*

The parameters of these drivers are defined by the device handler GPIB.COM and by the QuickBASIC program code. The following drivers and parameters are used in the program examples:

- The **IEEE-488.2** driver "Send" is used to send a command or query to an instrument.

  ```
  CALL Send (<board>, <address>, <command>, <eot>)
  ```

- The IEEE-488.2 driver "SendSetup" is used to prepare one or more devices to receive date bytes. The controller becomes talker and the device becomes listener.

  ```
  CALL SendSetup (<board>, <addresslist>)
  ```

- The IEEE-488.2 driver "SendDataBytes" is used to send data bytes from a talking controller to a listening device.

  ```
  CALL SendDataBytes (<board>, <data>, <eot>)
  ```

- The IEEE-488.2 driver "Receive" is used to read a response string from an instrument.

  ```
  CALL Receive (<board>, <address>, <response>, <term>)
  ```

- The IEEE-488.2 driver "SendIFC" is used to clear the GPIB interface.

  ```
  CALL SendIFC (<board>)
  ```

- The IEEE-488.2 driver "IbTMO" is used to specify a time out period for the interface board.

  ```
  CALL IbTMO (<board>, <timeout>)
  ```

Explanation of the parameters used in the IEEE-488.2 drivers:

- <board> — IEEE board identification inside the PC (default board address = 0).
- <address> — IEEE instrument address (default CombiScope Instrument address = 8).
- <addresslist> — Array containing GPIB device addresses, terminated by the constant -1 (FFFF hex.).
- <command> — A commend or query string to be sent to the instrument. The "short form" commends ere specified in UPPER CASE. The edditional cheracters in lower case complete the "long form" commands.
- <data> — One or more date characters to be sent to the listener device.

- <response> A response string sent by the instrument as a response to a query.
- <eot> An "end of text" indication:
  0 = program message to be continued (no action)
  1 = end of program message (sends End-message + EOI true)
- <term> A "terminate" indication:
  0 = response message to be continued (no detection of EOL character)
  256 = end of response message (stops reading after EOL character)
- <timeout> A time out indication, e.g., 11 = 1 second, 12 = 3 seconds, 13 = 10 seconds.

PROGRAM EXAMPLE:

```
'*****
'Initial program statements:
'*****
REM $INCLUDE:'c:\pc-gpib\488driv\QBDECL.BAS'  ' Includes GPIB drivers
CLS                                           ' Clears text from PC screen
CALL SendIFC(0)                               ' Clears the GPIB interface
CALL IbTMO(0, 13)                             ' Sets time out at 10 seconds
```

PROGRAMMING NOTE:

The variable IBCNT% contains the number of response bytes (including NL) after reading a response message using the Receive driver.

2.2 Initializing the CombiScope Instrument

2.2.1 How to reset the CombiScope instrument

The instrument itself can be reset by sending the *RST command. This sets the instrument to a fixed setup optimized for remote operation. The status and error data of the instrument can be cleared by sending the *CLS command.

PROGRAM EXAMPLE:

```
'*****
'Reset the instrument and clear the status data:
'*****
CALL Send(0, 8, "*RST", 1)          'Resets the instrument
CALL Send(0, 8, "*CLS", 1)          'Clears the status data
```

2.2.2 How to identify the CombiScope instrument

The identity of the instrument can be queried by sending the *IDN? query, followed by reading the instrument response message. The options of the instrument can be queried by sending the *OPT? query, followed by reading the instrument response message.

PROGRAM EXAMPLE:

```
'*****
'Read and print the identity and options of the instrument:
'*****
response$ = SPACE$(65)
CALL Send (0, 8, "*IDN?", 1)                    'Requests for identification
CALL Receive (0, 8, response$, 256)             'Reads the ident string
PRINT "Ident: "; LEFT$(response$, IBCNT%)       'Prints the ident string
CALL Send (0, 8, "*OPT?", 1)                    'Requests for options
CALL Receive (0, 8, response$, 256)             'Reads the options string
PRINT "Options: "; LEFT$(response$, IBCNT%)     'Prints the options string
```

2.2.3 How to switch between digital and analog mode

After power on, a CombiScope instrument can be either in the digital or analog mode. After a *RST command the digital mode is selected. The INSTrument subsystem allows you to switch between the two modes. This can be done by specifying a predefined name (DIGital, ANALog) or the corresponding number (1 = digital, 2 = analog).

PROGRAM EXAMPLE:

```
'*****
'Initialize and change the operating mode of the CombiScope instrument:
'*****
CALL Send (0, 8, "INSTrument ANALog", 1)        'Switches to analog mode
CALL Send (0, 8, "INSTrument:NSELect 1", 1)     'Switches back to digital mode
```

2.3 Error Reporting

Instrument errors are usually caused by programming or setting errors. They are reported by the instrument during the execution of each command. To make sure that a program is running properly, you must query the instrument for possible errors after every functional command. This is done by sending the SYSTem:ERRor? query or the STATus:QUEue? query to the instrument, followed by reading the response message. However, through this practice the same "error reporting" statements must be repeated after sending each SCPI command. This is not always practical. Therefore, one of the following approaches is advised:

1) Send the SYSTem:ERRor? or STATus:QUEue? query and read the instrument response message after every group of commands that functionally belong to each other.

2) Program an error-reporting routine and call this routine after each command or group of commands. For an example of an error-reporting routine, refer to section 3.14.4.1.

3) Program an error-reporting routine and use the "Service Request (SRQ) Generation" mechanism to interrupt the execution of the program and to execute the error-reporting routine. Therefore, refer to section 3.14.4.2.

PROGRAM EXAMPLE:

```
'*****
'Read error message:
'*****
er$ = SPACE$(60)
CALL Send(0, 8, "SYSTem:ERRor?", 1)      ' Requests for error
CALL Receive(0, 8, er$, 256)             ' Reads error message
PRINT "Response to error query = ";
PRINT LEFT$(er$, IBCNT%-1)               ' Displays error message
```

2.4 Acquiring Traces

Trace acquisitions are started via the INITiate commands. A single acquisition is done by sending a single INITiate command. Continuous acquisitions are done by sending the INITiate:CONTinuous ON command.

The TRACe? query allows you to acquire a trace of signal samples from one of the following sources:

- An input channel, e.g., CH2 (input channel 2).
- A trace area in a memory register, e.g., M2_3 (Memory register 2, trace 3).

The number of trace samples (acquisition length) can be specified using the TRACe:POINts command. If your instrument has standard memory, you can specify 512, 2048, 4096, or 8192 trace samples. If your instrument has extended memory, you can specify 512, 8192, 16384, or 32768 trace samples. A TRACe:POINts command specifies the acquisition length for all channels and memory registers.

Example: Send --> `TRACe:POINts CH1,8192` 'Selects 8192 sample points for all traces

The number of trace sample bits can be specified using the FORMat command. This gives you the possibility to define samples of 8 bits (1 byte) or 16 bits (2 bytes). A FORMat command specifies the number of sample bits for all channels and memory registers.

Example: Send --> `FORMat INT,16` 'Formats 16-bits samples

The format of the trace response data is as follows:

```
# n x . . x f b . . . . . b s <NL>
```

NewLine code (10 decimal)
checksum byte over all trace bytes
trace sample data bytes (see Note)
trace data format byte (see Note)
number of trace bytes (fbb...bbs)
number of digits of x..x

Note: *If f=8 decimal, each trace sample is one byte (8 bits).*
If f=16 decimal, each trace sample is two bytes (16 bits), i.e., most significant byte (msb) + least significant byte (lsb).

Example:

```
# 4 1 0 2 6 <16> <msb 1> <lsb 1> . . . <msb 512> <lsb 512> <checksum> <10>
```

trace sample 512
trace sample 1
decimal 16
number of trace bytes (N)
number of digits of N

2.4.1 How to acquire a single shot trace

In the program example, a single shot trace acquisition of 8192 8-bit samples is done with a probe connected to input channel 1. The trace sample bytes are read from the GPIB as string characters. The number of response bytes and the number of samples are printed.

The TRIGger:SOURce command is used to specify input channel 1 as a trigger source. The TRIGger:LEVel command is used to reset the trigger level to e.g., 0.1 volts.

PREPARATIONS:

- Connect a probe to channel 1. After start up of the program you will be asked to trigger the acquisition with the open end of the probe, i.e., touch the probe or strike the probe on the table.

PROGRAM EXAMPLE:

```
'*****
'Acquire a single shot trace:
'*****
DIM tracebuf AS STRING * 16500
CALL Send(0, 8, "FORMat INTeger,8", 1)              ' Formats 8-bits sample
CALL Send(0, 8, "TRACe:POINts CH1,8192", 1)         ' Formats 8192 sample points
CALL Send(0, 8, "TRIGger:SOURce INTernal1", 1)      ' Trigger-source = channel 1
CALL Send(0, 8, "TRIGger:LEVel 0.1", 1)             ' Trigger-level = 0.1
CALL Send(0, 8, "INITiate", 1)                      ' Single shot initiation
PRINT "Trigger the CombiScope instrument by touching the probe tip."
PRINT ">>> Press any key when finished."
WHILE INKEY$ = "": WEND
CALL Send(0, 8, "*WAI", 1)                          ' Waits for previous commands
                                                      to finish
CALL Send(0, 8, "TRACe? CH1", 1)                    ' Queries for channel 1 trace
CALL Receive(0, 8, tracebuf$, 256)                  ' Reads channel 1 trace
'
' The contents of the tracebuf$ string is as follows:
' # 4 8194 <8> <byte 1> ... <byte 8192> <sum> <10>
'
nr.of.digits = VAL(MID$(tracebuf$, 2, 1))
nr.of.bytes = VAL(MID$(tracebuf$, 3, nr.of.digits)) - 2
sample.length = ASC(MID$(tracebuf$, 3 + nr.of.digits, 1)) / 8
nr.of.samples = nr.of.bytes / sample.length
PRINT "Number of bytes received ="; IBCNT%          ' IBCNT% = number of bytes
PRINT "Number of trace samples ="; nr.of.samples
```

Note: *Refer to section 3.4.3 "Conversion of trace data" about how to convert this string data.*

2.4.2 How to acquire repetitive traces

In the program example, 5 trace acquisitions of 512 16-bit samples are done via a probe connected to channel 2. The trace semple bytes are read from the GPIB es string characters and written to the file TRACE5.DAT on the hard disk.

PREPARATIONS:

- Connect a probe from the Probe Adjust signel to channel 2.

PROGRAM EXAMPLE:

```
'*****
'Acquire 5 sequential traces and store in file TRACE5.DAT:
'*****
DIM tracebuf AS STRING * 1050
CALL Send(0, 8, "*RST", 1)                      'Resets the instrument
'
'After *RST a trace acquisition is defined at 512 samples of 16 bits
'(2 bytes).
'
CALL Send(0, 8, "CONFigure:AC (@2)", 1)         'Configures channel 2
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage2'", 1) 'Switches channel 2 on
OPEN "O",#1,"TRACE5.DAT"                        'Opens file TRACE5.DAT
  FOR i=1 TO 5
    CALL Send(0, 8, "INITiate", 1)              'Single initiation
    CALL Send(0, 8, "*WAI;TRACe? CH2", 1)       'Queries for channel 2 trace
    '
    'Notice the *WAI; before TRACe?. The *WAI command takes care that the TRACe? CH2 command is
    'executed when the INITiate command is finished.
    '
    CALL Receive(0, 8, tracebuf$, 256)          'Reads channel 2 trace
    PRINT #1, "Trace buffer:"; i                'Writes trace header to file
    PRINT #1, LEFT$(tracebuf$, IBCNT%)          'Writes trace buffer to file
  NEXT i
CLOSE.                                          'Closes file TRACE5.DAT
```

Note: Refer to section 3.4.3 "Conversion of trace data" about how to convert this string data.

2.5 Measuring Signal Characteristics

The measurement instructions allow you to make a complete measurement. This includes the configuration of the instrument, the initietion of the trigger system, and the fetching of the acquisition dete. The measurement instructions can be used at different levels, varying in processing time. The highest level is the most eesy to use, but tekes more time to complete than the lowest level. The following levels of measurement instructions can be used:

The highest level: **MEASure?**
(easy to use)

The middle level: **CONFigure + REAO?** (equivalent to MEASure?)
(gives more programming flexibility)

The lowest level: **INITiate + FETCh?** (equivalent to READ?)
(to acquire more signal characteristics)

The following table shows which measurement tasks are executed by the measurement instructions:

	MEASure?	CONFigure	READ?	INITiate	FETCh?
Configures the instrument:	YES	YES			
Initiates the trigger system:	YES		YES	YES	
Fetches the acquired data:	YES		YES		YES

2.5.1 How to make a single shot measurement

The MEASure? query allows you to make a single-shot measurement, and the FETCh? query allows you to fetch more signal characteristics.

PROGRAM EXAMPLE:

```
'*****
'Measure and print the AC-RMS, peak to peak, and amplitude of
'the signal on channel 1.
'*****
response$ = SPACE$(30)
CALL Send (0, 8, "MEASure:AC? (@1)", 1)          ' Measures the AC-RMS value
CALL Receive (0, 8, response$, 256)               ' Reads the AC-RMS value
PRINT "AC-RMS value      : "; LEFT$(response$, IBCNT% -1)
CALL Send (0, 8, "FETCh:PTPeak?", 1)              ' Fetches the Peak-To-Peak value
CALL Receive (0, 8, response$, 256)               ' Reads the PTP value
PRINT "Peak-To-Peak value: "; LEFT$(response$, IBCNT% - 1)
CALL Send (0, 8, "FETCh:AMPLitude?", 1)           ' Fetches the amplitude value
CALL Receive (0, 8, response$, 256)               ' Reads the amplitude value
PRINT "Amplitude value   : "; LEFT$(response$, IBCNT% - 1)
```

2.5.2 How to make repeated measurements

The measurement instructions allow you to make repeated measurements. The CONFigure command allows you to configure the instrument, the READ? query allows you to make a measurement, and the FETCh? query allows you to fetch more signal characteristics.

PROGRAM EXAMPLE:

```
'*****
'Measure and print 5x the AC-RMS, peak to peak, and
'amplitude of the signal on channel 1.
'*****
response$ = SPACE$(30)
CALL Send (0, 8, "CONFigure:AC (@1)", 1)          ' Configures for AC-RMS
FOR i = 1 TO 5                                     ' Performs 5 measurements
  CALL Send (0, 8, "READ:AC?", 1)                  ' Initiates AC-RMS reading
  CALL Receive (0, 8, response$, 256)              ' Reads the AC-RMS value
  PRINT "AC-RMS: "; LEFT$(response$, IBCNT%-1);
  CALL Send (0, 8, "FETCh:PTPeak?", 1)             ' Fetches the Peak-To-Peak value
  CALL Receive (0, 8, response$, 256)              ' Reads the PTP value
  PRINT " / Peak-To-Peak: "; LEFT$(response$, IBCNT%-1);
  CALL Send (0, 8, "FETCh:AMPLitude?", 1)          ' Fetches the amplitude value
  CALL Receive (0, 8, response$, 256)              ' Reads the amplitude value
  PRINT " / Amplitude: "; LEFT$(response$, IBCNT%-1)
NEXT i
```

3 USING THE COMBISCOPE INSTRUMENTS

3.1 Introduction

This chapter explains how to access the functions of the CombiScope instruments family in a remote programming environment. For that purpose, the CombiScope instrument is equipped with an IEEE-488 compatible GPIB interface and implements a full SCPI compatible command set which provides an extensive range of remote control facilities.

Traditionally, there was no standard for the remote operation of instruments. A wide range of different command sets existed. Each set had its own terminology and trade-offs, based upon the implementations and corresponding limitations of the instrument. Similar functions in different instruments were controlled by different commands. And, vice versa, identical commands could easily exist in another instrument to control a different function. With new technologies and increasing complexity, other programming concepts were introduced. This caused programs with identical functions to look different when written for another instrument.

The remote control of instruments became a cumbersome process, which required a high learning curve for each new instrument and each additional instrument. The time and costs to create and maintain application programs were unnecessarily high due to the lack of standardization.

With the introduction of the Standard Commands for Programmable Instruments, commonly called SCPI, a lot of progress has been made in this area. The development time of an application program for SCPI-compatible instruments, like the CombiScope instrument, is considerably reduced. This is mainly achieved by the consistent programming environment for instrument control and data usage across all types of instruments that, regardless of the manufacturer, is provided by SCPI.

The standardized commands allow the same functions in different types of instruments to be controlled by the same commands. For example, the query MEASure:FREQuency? acquires the frequency characteristic of the input signal, regardless of whether the instrument is a frequency counter, an oscilloscope, or any other measuring instrument.

As the example already shows, the commands are easy to learn and self-explanatory to both novica and expert users. Tha learning curva is considerably decreased for new instruments or instrumant functions with which the programmer is not familiar.

Efficiency is not only gained when craating or debugging new application programs. The aasily undarstandable programs greatly simplify maintananca and modification of axisting application programs that have bean written by othar persons or for othar Instrumant functions.

All major CombiScope instrument functions are controlled by standard SCPI commands. Although the functionality provided is the same, the way the oscilloscope is controlled via the remote interface differs in some aspects from the front panel operation. This is because the local front panel operation is designed to allow you to take maximum advantage of the interactive communication possibilities offered by the display screen. This allows for additional information and guidance during the process of local operation.

The remote command set is based upon an instrument model that is easy to understand. This model provides a structured survey of the implemented instrument functions and serves as a guide towards the commands that control these functions. This other view allows for optimal and easy access of the instrument functions when operated from the remote interface. Additionally, a measurement instruction set allows for easy programming of measurement tasks for a wide variety of signal characteristics.

3.2 Fundamental Programming Concepts

The remote operetion of your CombiScope instrument cen be accessed using different progremming concepts. The concept to be chosen depends upon the epplication of the instrument in the remote programming environment. Eech of the four concepts hes it own benefits end trade-offs.

1) Using measurement instructions

Advantage:	Easy to program. No instrument knowledge required to make measurements. So, you can start programming quickly and get measurement results rightaway.	
Trade-off:	A measurement takes some time to complete, because the instrument automatically searches for optimal settings.	
Example:	**MEASure:FREQuency?**	Measures the frequency of the signal at channel 1.

2) Single function programming using the instrument model

Advantage:	Allows you to program individual functions separately through single commands. The instrument model gives the relation between the commands and the functions of the CombiScope instrument.	
Trade-off:	Requires understanding of the remote operation of the instrument functions.	
Example:	**TRACe? CH1**	Returns the acquisition trace of the signal at channel 1.

3) Programming the complete instrument setup

Advantage:	Simple to program. No worry about individual settings. This method can also be used to save and recall settings, which are not individually programmable.	
Trade-off:	Processes complete instrument setups. Individual settings must be set or programmed separately.	
Example:	***SAV 3**	Saves actual instrument settings to internal memory 3.
	***RCL 3**	Recalls instrument settings from internal memory 3.

4) Programming through front penel simulation

Advantage:	Gives the possibility to program settings for which no remote commands are available, i.e., to match a front penel setup.

Trade-off:	This way of programming is cumbersome and tricky, because additional information on the front panel display is not always available remotely.	
Example:	**DISPlay:MENU TRIGger**	Activates the TRIGGER softkey menu.
	SYSTem:KEY 4	Simulates the pressing of softkey 4. The effect is that TRIGGER menu option "noise" is switched on or off.

3.2.1 Measurement instructions

This is a completely new approach in the remote operation of programmable instruments, which provides a set of task-oriented measurement instructions. Rather than programming every instrument setting separately with starting the acquisition and calculating the result, just specify the desired signal characteristic, and the CombiScope instrument returns the requested result. Depending upon the actual available signal, your CombiScope instrument automatically determines the optimal settings to acquire and calculate the requested result.

An example of such a command is the MEASure:FREQuency? query, which not only works on oscilloscopes, but also on different types of SCPI-compatible instruments, such as counters and multimeters.

With traditional oscilloscopes you had to do the following:

- set up all functions of the oscilloscope separately.
- start the acquisition of the data.
- position the cursor markers.
- calculate the frequency from the acquired data.
- read the calculated frequency from the instrument.

A single, simple SCPI query replaces all of the above, namely the MEASure:FREQuency? query which does the following:

- auto configures the oscilloscope to the best possible setting for the requested measurement task.

  Note: This process is different from the traditional AUTOSET process in that tha autoset function detarmines the instrument settings based on the input signal only, whereas, the auto configure algorithm also takes tha dasirad measurament task into account.
- starts the acquisition process.
- takes care that the measurement is triggered.
- calculates the desired characteristic from the acquired data.
- returns the calculated valua.

The measurement instructions are easy to use and do not require any special knowledge of the instrument. The programming concept reduces simple measurement tasks with complex instruments to simple instructions, leaving the setup complexity to the instrument. The measurement instructions are extremely useful when the applicetion does not require the precise setting of instrument functions. The concept is extendible with separate control of perameters that are vital to the application.

3.2.2 Single function programming using the instrument model

All major instrument functions such as time base, input impedance, etc, are separately programmable using "single parameter" commands. The easy to understand command set is comparable with the way instruments are traditionally controlled. This concept gives you full control over all functions and power of a modern oscilloscope. However, for maximum benefit of all the advanced features of your CombiScope instrument, you need some understanding of their remote operation.

Functions of the CombiScope instrument that belong together are grouped into subsystems. There are several subsystems, each representing a particular function. The instrument model in the following figure gives an overview of the most important subsystems.

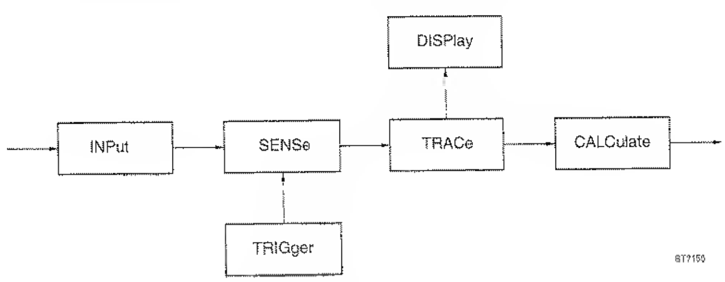


Figure 3.1 The Instrument Model for CombiScope instruments

EXPLANATION OF THE INSTRUMENT MODEL:

- All functions thet deal with signal conditioning are pert of the INPut subsystem.
- In a similar wey the SENSe subsystem contains the data acquisition part where the anelog signal is converted into a digital value.
- The results of the acquisition ere stored in a TRACe subsystem memory.
- Post-processing functions on the acquired data are available in the CALCulate subsystem.
- The TRIGger subsystem deals with the control of the acquisition process.
- The DISPlay subsystem handles the front panel display functions.

Functions in a particular subsystem are always controlled by commands that begin with the name of that subsystem. For example, a command that programs the input coupling is INPut:COUPling DC.

All progremmable settings can be queried easily. The query form is obtained from the command by simply removing the parameter and adding a question mark. For example, the commend to program the input impedence of your oscilloscope is INPut:IMPedance 50. This impedance value can be queried by sending INPut:IMPedence? which returns 50.

3.2.3 Instrument setup

This concept allows you to program instrument settings with a single command. Several instrument setups can be saved, either created by remote programming or by front panel control. This concept can also be used to program instrument functions that cannot be directly accessed using individual program instructions. Complete instrument setups can be saved either in the internal memory of the oscilloscope or externally in the remote controller. A part of the instrument setup can also be saved externally.

The oscilloscope is equipped with a number of internal memories in which the complete instrument set up can be saved and from which it can be restored.

Send → *SAV 3	Saves the current set up into memory 3.
Send → *RCL 3	Recalls the instrument set up that was saved in memory 3.

Instead of using an internal oscilloscope memory, the instrument setup can be queried using the SYSTem:SET? query. The result of this query is that the oscilloscope sends a part or the complete setup in a compact block data format. Sending this data back as a parameter with the SYSTem:SET command reprograms the oscilloscope to the same settings.

Example for the complete instrument settings:

Send → SYSTem:SET?	Queries the oscilloscope for the complete instrument setup.
Read ← <block_data>	Reads the <block_data> response, which contains the requested instrument setup, from the oscilloscope.
Send → SYSTem:SET <block_data>	Sends the previously read instrument setup back to the oscilloscope in the same <block_data> format.

Example for the instrument cursor settings:

Send → SYSTem:SET? 32	Queries the oscilloscope for the instrument settings of node 32, which are the cursor settings.
Read ← <settings>	Reads the cursor settings.
.	
.	
Send → SYSTem:SET <settings>	Restores the cursor settings.

3.2.4 Front panel simulation

This concept allows you to send commands that simulate the pressing of a front panel key. This method allows the remote operation to precisely match a front panel setup. In particular, this method can be used to access instrument functions that cannot be programmed directly by remote commands.

As described in the beginning of this section, there is a difference between the front panel operation and the remote control of an instrument. If you use the front panel simulation commands via the remote interface, be aware that no use can be made of the additional information that is presented on the screen of the oscilloscope. As this causes the front panel simulation method to be a tedious process, it is certainly not recommended as a common programming practice.

For example, the SYSTem:KEY 507 command switches the AVERAGE function on when it was switched off before. When this function was switched on before, the AVERAGE function is switched off. The effect of the SYSTem:KEY command completely depends upon the state of the instrument at the moment the command is received. In a remote programming environment it is not immediately clear whether a state is on or off. For that reason the command SENSe:AVERage ON is much better.

To select functions that cannot be programmed directly, you might use the front panel simulation commands. For example, the command SYSTem:KEY 4 switches the "noise suppression" option in the TRIGGER menu of the front panel ON or OFF.

3.3 Measuring Signal Characteristics

As explained in section 3.2.1 "Measurement instructions", the measurement instruction set is a new approach in the remote operation of programmable instruments. This instruction set allows you to request a particular characteristic of the input signal. The CombiScope instrument then chooses the best possible settings, executes the requested task, and returns the desired result.

Within the measurement instruction set, different programming levels can be distinguished. The highest level is the easiest to use, but the trade-off is less flexibility. Lower levels provide more flexibility by offering more control over the instrument functionality. This requires more knowledge about the remote operation of your instrument.

The measurement instructions specify a particular task in terms of the expected signal and the desired result. The instructions refer to the signal characteristics of the signal being measured. This makes them independent from the implementation of the instrument functions. For example, when the instruction MEASure:FREQuency? is executed, it is not important whether this frequency is measured by precisely counting the signal period, or if it is calculated from a sampled waveform. For this reason, the measurement instructions provide the best compatibility among different types of instruments. But, as a trade-off, the compatibility decreases when more flexibility is needed and lower measurement instruction levels are used.

3.3.1 The MEASure? query

This is the easiest instruction to use and provides the best compatibility. However, it does not offer access to the full capability of the CombiScope instrument. The MEASure? query configures the instrument for optimal settings, starts the data acquisition, and returns the result in one operation. The signal characteristics that can be acquired in this way are shown in figure 3.2.

Example:

MEASure:AC?

This query measures the RMS voltage of the AC component at the default input channel 1. After the acquisition, the result is sent to the controller. The instrument itself selects an optimal setting for this purpose and carries out the requested measurement as "well" as possible. Moreover, it automatically starts the measurement.

3.3.2 Benefits of using parameters

The generic form of a measurement instruction is as follows:

MEASure[:VOLTage]:<measure_function>?
[[<voltage_parameters>,]<measure_parameters>][,<channel_list>]

The :VOLTage keyword is a default node, which specifies the signal characteristic to be measured, relates to the voltage component of the signal. The <measure_function> specifies the desired signal characteristic.

The parameters can be used to provide additional information to the instrument about the expected signal and the desired result. The oscilloscope uses this information to determine the best settings for the requested task. As the syntax shows, the parameters can be left out (defaulted). In that case, the oscilloscope chooses it own settings based upon the actual available input signal and its own trade-offs. The result of defaulting parameters is that the measurement needs more time to complete.

The VOLTage parameters relate to the :VOLTage node in the header. These parameters specify the expected voltage and the desired resolution:

<voltage_parameters> = [<expected_voltage>[,<resolution>]]

The expected voltage in the parameter specification is assumed to be the value at the BNC input of the oscilloscope. When a detectable probe is attached, it is assumed to be the value at the probe tip.

When the <expected voltage> parameter is defaulted, the oscilloscope performs an autorange, which needs some additional time. When a particular value was specified instead, the oscilloscope immediately selects the range next higher to the specified voltage, omitting the relative time-consuming autoranging.

Notice that when voltage parameters are used, the :VOLtage node must be sent explicitly in the command header. Or, in other words, when the :VOLTage node is defaulted, the voltage parameters must also be defaulted.

Examples:

MEASure:AMPLitude?
This query measures the amplitude of a waveform at the default input channel 1. After the acquisition, the resulting amplitude is returned.

MEASure:VOLTage:AMPLitude? 10, (@2)
This query measures the amplitude of a signal at channel 2 (@2). But, since it specifies the expected voltage value (10 volts), it will complete the measurement faster.

In a similar way the measure function parameters provide the oscilloscope with information about the signal characteristic to be measured. The parameters that are allowed depend upon the requested signal characteristic (measure function).

The measure function parameters that specify a voltage characteristic, such as :AC, :AMPLitude, :HIGH, :MINimum, etc, use the voltage parameters for that purpose. Measure functions, such as fall and rise time, frequency and period, use time units. Their expected value and desired resolution are specified in seconds or Hertz as separate measure parameters.

Examples:

MEASure:VOLTage:FREQuency? 10E6, (@3)
This query measures the frequency of the signal at input channel 3. The expected frequency is 10 MHz, whereas, the expected voltage is defaulted. Notice that this command is equivalent to the **MEASure:FREQuency? 10E6, (@3)** command.

MEASure:VOLTage:FREQuency? 5, 10E6, (@3)
This query does the same as the previous example, except that the expected voltage is 5 volts.

3.3.3 Waveform measurements

The following figure shows the terms used for pulse measurements and the key words that are used as header nodes in the measurement instructions.

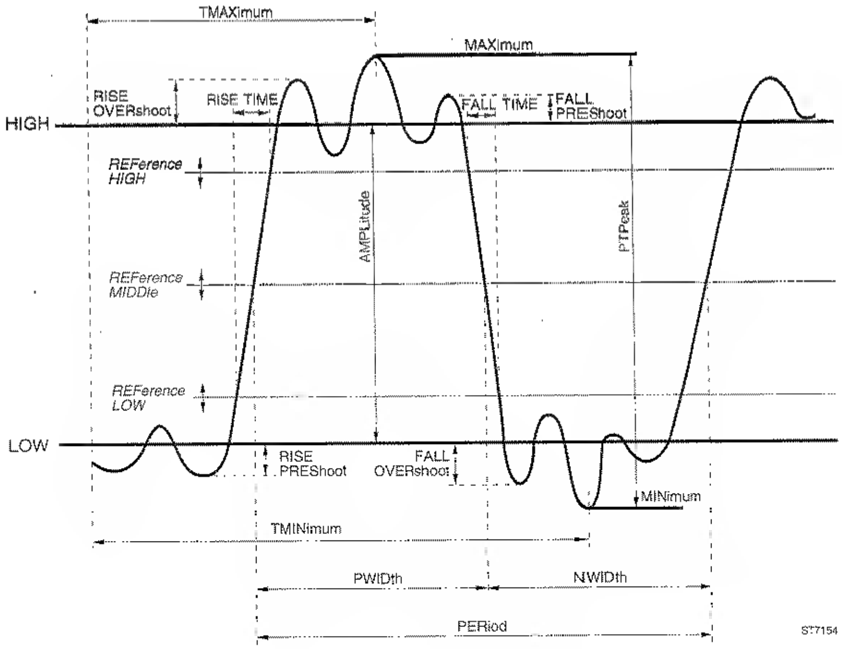


Figure 3.2 Pulse characteristics

The reference high and low parameters determine the desired interval for rise time and fall time measurements. The default low and high references are 10% and 90% of the pulse amplitude (= HIGH - LOW).
Default REFerence LOW =LOW + 0.1 * (HIGH - LOW)
Default REFerence HIGH =LOW + 0.9 * (HIGH - LOW)

In a similar way, the reference middle parameter determines the desired interval for pulse width (PWIDth, NWIDth) and duty cycle (PDUTycycle, NDUTycycle) measurements. When defaulted, the reference middle value is assumed to be at 50% of the amplitude.
Default REFerence MIDDle =LOW + 0.5 * (HIGH - LOW)

Examples:

MEASure:FALL:TIME? (@3)

Measures the time interval during which the pulse at channel 3 decreases from 90% to 10% of its amplitude.

MEASure:RISE:TIME? 20,80

Measures the time interval during which the pulse at the default channel 1 increases from 20% to 80% of its amplitude.

The following measure functions and parameters can be programmed:

```
<measure_function><measure_parameters>
:AC
:AMPLitude
[:DC]
:FALL
  :OVERshoot
  :PREShoot
  :TIME          [<reference_low> [,<reference_high> [,<expected_time>
                                                  [,<time_resolution>]]]]
:FREQuency       [<expected_frequency> [,<frequency_resolution>]]
:HIGH
:LOW
:MAXimum
:MINimum
:NDUTycycle      <reference_middle>
:NWIDth          <reference_middle>
:PDUTycycle      <reference_middle>
:PERiod          [<expected_period> [,<period_resolution>]]
:PTPeak
:PWIDth          <reference_middle>
:TMAXimum
:TMINimum
:RISE
  :OVERshoot
  :PREShoot
  :TIME          [<reference_low> [,<reference_high> [,<expected_time>
                                                  [,<time_resolution>]]]]
```

Notes: - *:DCYCle = alias for :PDUTycycle*
- *:FTIMe = alias for :FALL:TIME*
- *:RTIMe = alias for :RISE:TIME*

3.3.4 Customizing settings

Often, you need more precise control of the measurements than possible with the MEASure? query. The combination of CONFigure and READ? is provided to allow you to program one or more settings that are vital to your application. Executing this sequence of instructions is equivalent to sending MEASure? For setting up the instrument, CONFigure uses the same measure functions and parameters as MEASure?. The CONFigure command does the instrument setup portion of MEASure?. The READ? query initiates the acquisition, performs the needed calculations, and returns the desired result.

Since READ? no longer changes instrument settings, commands that are executed after CONFigure, but before READ?, are taken into effect by the acquisition. This concept allows you to perform a generic configuration through CONFigure and then customize the measurement by programming the settings that are vital to your application. Next the READ? completes the measurement process.

Example:

CONFigure:AC	Configures the instrument to perform an RMS measurement of the AC component at the default input channel 1.
SENSe:AVERage ON	Sets averaging on.
SENSe:AVERage:COUNT 4	Sets averaging factor at four.
READ:AC?	Starts the measurement and returns the averaged AC-RMS value.

READ? uses the same measure functions and parameters as CONFigure. After the instrument has been set up for a particular measure function by the CONFigure command, the same measure function key words can be repeated by the READ? query header. Moreover, it is allowed to request for another signal characteristic by specifying a measure function other than that for which the instrument was configured. However, keep in mind that the instrument was set up by CONFigure for another task. As these settings are not affected by READ?, it is not guaranteed that the instrument is able to acquire the signal characteristic that is requested by READ?

Example:

CONFigure:AC	Sets up the instrument to perform an RMS measurement of the AC component.

READ? Requests to execute the default DC measurement. Since this is not possible with the chosen configuration, an execution error is generated and no result is returned.

CONFigure:RISE:TIME Configures the CombiScope instrument to perform a rise time measurement.

READ:RISE:OVERshoot? Requests to read the rise time overshoot. Because the CombiScope instrument is able to celculate the rise overshoot value when it is set up for a rise time measurement, the desired result is calculated and returned.

A READ? also allows the same parameter sets as the corresponding CONFigure instructions. But, these sets only serve to specify the desired result. They are ignored as far as they affect instrument settings. The parameters can be sent for compatibility with the preceding CONFigure command.

Example:

CONFigure:RISE:TIME Configures the oscilloscope to perform a default rise time measurement (10% to 90% increase of the signal amplitude).

READ:RISE:TIME? 20,80 Requests for the rise time of the 20 to 80% increase of the signal amplitude. As the CombiScope instrument is able to respond to this request, the desired rise time is calculated and returned.

3.3.5 Multiple measurements

Sometimes it is necessary to perform multiple measurements of the same signal characteristic. This can be realized by executing multiple MEASure? queries. However, this implies that the relative time-consuming configuration portion of MEASure? is unnecessarily repeated. This can be easily avoided by using the CONFigure and READ? concept as described in the preceding chapter. This concept allows you to do the configuration only once by sending the CONFigure command one time. Sending multiple READ? queries next, causes the instrument to repeatedly execute the desired measurement.

Example:

CONFigure:FREQuency Configures the instrument to perform a frequency measurement.

READ:FREQuency?	Starts the acquisition and returns the measured frequency.
READ:FREQuency?	Starts a next acquisition and returns the new frequency result.
READ:FREQuency?	Etc.

3.3.6 Multiple characteristics from a single acquisition.

It is often necessary to determine several signal characteristics from the last acquired waveform. Starting a new acquisition, as READ? and MEASure? do, is undesired. For that purpose, READ? is broken down into two additional instructions, which are the INITiate[:IMMediate] command and the FETCh? query. Executing this sequence of instructions is equivalent to READ?. The INITiate[:IMMediate] command starts the acquisition. FETCh? determines the requested signal characteristic and returns the result. This concept allows you to perform several different FETCh? queries on a single set of acquisition data.

Example:

MEASure:AC?	Configures the instrument to measure the RMS value of the AC component of the signal at input channel 1, starts the acquisition, and returns the desired result.
FETCh:FREQuency?	Determines and returns the frequency of the signal that is acquired by the preceding MEASure? query.
FETCh:RISE:TIME?	Uses default parameters to determine and return the rise time of the first pulse.

As distinct from the READ? query, defaulting the measure function part of the FETCh? query, causes the CombiScope instrument to return the characteristic that was requested with the last executed FETCh?, READ? or MEASure? query. For this reason, the measure function should always be explicitly specified in the header of the FETCh? query.

3.3.7 Trigger control via GPIB

You need e separete GPIB commend to start e measurement synchronized with other instruments. This is done by sending the *TRG command or the GET (Group Execute Trigger) code. The MEASure? and READ? queries do not allow you to do so, because such a setup causes a query error. With the INITiate[:IMMediate] end FETCh? concept, it is possible to meet the requirements of such applications.

Example:

CONFigure:AC	Configures the instrument to measure the AC-RMS voltage.
TRIGger:SOURce BUS	Specifies that the acquisition is to be triggered by GET or *TRG.
INITiate	Starts the measurement process.
***TRG**	Triggers the acquisition.
FETCh:AC?	Determines and returns the AC-RMS value.

3.3.8 Fetching characteristics from memory traces

The FETCh? query not only allows you to determine a characteristic from the last acquired waveform, it also allows you to calculate a signal characteristic from a waveform that is stored in a trace memory element.

Example:

FETCh:RISE:TIME? (@M3_4)	Calculates and returns the default rise time from a waveform that is stored in trace memory M3_4.
FETCh:PERiod? (@M4_1)	Determines and returns the period of the waveform that is stored in trace memory M4_1.

Notice that such a FETCh? query operates properly only when there is valid waveform data stored in the trace memory.

PROGRAM EXAMPLE:

In this example the signal acquired via channel 2 is stored in memory register 1. The AC-RMS, peak-to-peak, and amplitude values of the stored signal are fetched and printed.

```
DIM response AS STRING * 10
CALL Send(0, 8, "CONFigure:AC (@2)", 1)            ' Configures for channel 2
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage2'", 1) ' Switches channel 2 on
CALL Send(0, 8, "INITiate", 1)                     ' Single initiation
CALL Send(0, 8, "TRACe:COPY M1_2,CH2", 1)          ' Copies CH2-trace to M1_2
'
' Now trace area 2 of memory register 1 is filled with the channel 2 trace.
'
CALL Send(0, 8, "FETCh:AC? (@M1_2)", 1)            'Fetches AC-RMS of M1_2
CALL Receive(0, 8, response$, 256)                 'Enters AC-RMS value
PRINT "AC-RMS value : "; response$                 'Prints AC-RMS value

CALL Send(0, 8, "FETCh:PTPeak? (@M1_2)", 1)        'Fetches Peak-To- Peak of M1_2
CALL Receive(0, 8, response$, 256)                 'Enters Peak-To-Peak value
PRINT "Peak-To-Peak value: "; response$            'Prints Peak_to_peak value

CALL Send(0, 8, "FETCh:AMPLitude? (@M1_2)", 1)     ' Fetches amplitude of M1_2
CALL Receive(0, 8, response$, 256)                 ' Enters amplitude value
PRINT "Amplitude value : "; response$              ' Prints amplitude value
```

3.4 Acquisition

3.4.1 Acquisition control

Several commands exist to control the acquisition process. The following diagram shows the possible states of the acquisition process, and the way they are affected by commands.

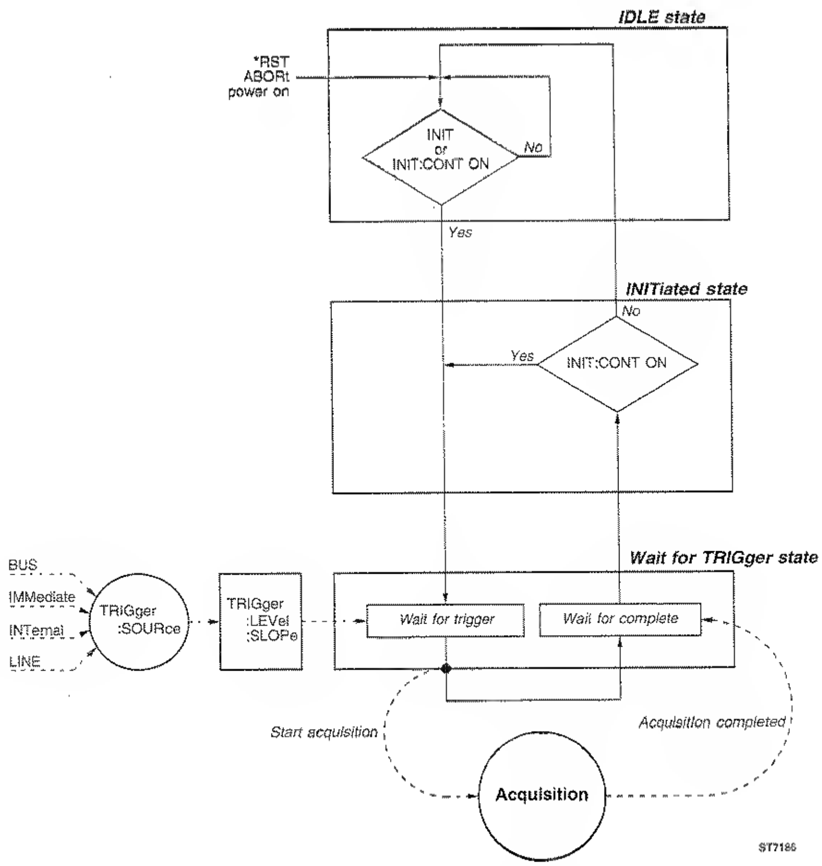


Figure 3.3 The Trigger Model for acquisitions

The trigger model shows that after a *RST command, the instrument is in the IDLE state. An acquisition doesn't start until an INITiate command is received. Initiation of the oscilloscope occurs by sending the INITiate[:IMMediate] command

or by setting INITiate:CONTinuous to ON. The INITiate[:IMMediate] command causes the CombiScope instrument to perform one complete acquisition cycle. Upon completion of the cycle the instrument returns to the IDLE state.

The INItiate:CONTinuous command is used to select whether the instrument is continuously initiated or not. When INItiate:CONTinuous is set to ON, the instrument immediately exits IDLE and starts an acquisition cycle. On completion of each cycle, the instrument does not return to the IDLE state, but immediately starts another acquisition cycle.

Before the acquisition takes place, the trigger conditions must be satisfied. These conditions are programmable to suit the needs of your application, as described in the next section. After a *RST command, there are no trigger conditions to be met. So, an INITiate command causes the CombiScope instrument to immediately trigger the acquisition.

Executing the measurement instructions MEASure? and READ? causes the acquisition to become initiated automatically. No separate INITiate commands are needed. When the FETCh? instruction is used, the instrument must have been initiated either by a preceding INITiate[:IMMediate] command, or implicitly by a READ? or MEASure? instruction.

When the CombiScope instrument receives the ABORt command, any acquisition that is in progress is aborted immediately, and the instrument returns to the IDLE state. The same occurs when *RST is received. The ABORt command distinguishes from *RST in that *RST also resets the instrument settings, whereas, ABORt does not. For example, when INITiate:CONTinuous is set to ON, a *RST command not only aborts the pending acquisition and forces the instrument to the IDLE state, but it also sets INITiate:CONTinuous to OFF, preventing the acquisition to initiate again. Since ABORt does not affect the instrument settings, an aborted acquisition cycle is immediately initiated again.

When the instrument is in the IDLE state, the "no-pending operation" flag that is associated with the acquisition is set True. The *OPC and *OPC? commands use this flag to signal their "Operation Completed" response. Notice that if INITiate:CONTinuous is set to ON, the instrument does not return to the IDLE state when an acquisition cycle has completed. This means that no "Operation Completed" response is generated after the *OPC and *OPC? commands.

3.4.1.1 Triggering

After the measurement is initiated, the CombiScope instrument starts the real acquisition when the trigger conditions are satisfied, e.g., when the selected trigger event occurs. The trigger conditions can be ignored during a specific hold-off time, which can be programmed using the TRIGger:HOLDoff command. During the hold-off time the event detector is inhibited from acting on any trigger.

Trigger Type

The TRIGger:TYPE command selects the type of triggering, which can be programmed to EDGE triggering (normal trigger mode), VIDeo triggering (refer to section 3.4.1.2 "Video triggering"), LOGic, or GLITch triggering. After a *RST command, the trigger type is EDGE.

Note: Logic state, pattern, or glitch settings cannot be programmed using SCPI commands.

Trigger Source

The TRIGger:SOURce command selects the source for the trigger event. The receipt of the GPIB interface message GET (Group Execute Trigger) or the common command *TRG serves as the trigger event when BUS is selected as trigger source.

The trigger event is determined by the AC line voltage when LINE is selected, and is derived from the input signal when INTernal is programmed as trigger source.
For the 2-channel CombiScope instruments, EXTernal can be programmed as the trigger source. In that case, channel 4 is selected as external trigger input.
A numeric suffix is used to specify the channel number. For example, TRIGger:SOURce INT2 selects the signal at input channel 2 to trigger the acquisition.

When IMMediate is selected, an acquisition does not wait for a trigger event. So, an INITiate command causes the acquisition to begin immediately. After a *RST command, the trigger source is IMMediate, which means no trigger is required.

Trigger Level

The TRIGger:LEVel command allows you to set the trigger level for all input channels. Programming the trigger level automatically switches off level peak-peak. The trigger level can be programmed only when the TRIGger:SOURce is INTernal. The TRIGger:LEVel:AUTO command allows you to switch level peak-peak on or off. Switching on level peak-peak, deactivates the trigger level. After a *RST command the TRIGger:LEVel is set to its maximum value and level peak-peak is switched off.

Trigger Slope

The TRIGger:SLOPe command allows you to define the trigger edge for all input channels, which can be POSitive, NEGative, or EITHer. After a *RST command the TRIGger:SLOPe is set to POSitive.

PROGRAM EXAMPLE:

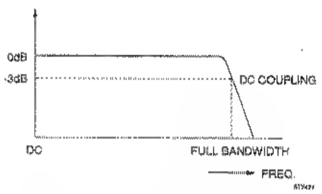
```
CALL Send(0, 8, "CONFigure:PTPeak (@2)", 1)           ' Configures channel 2
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage2'", 1) ' Sets channel 2 ON
CALL Send(0, 8, "TRIGger:SOURce INTernal2", 1)        ' Trigger source = channel 2
CALL Send(0, 8, "TRIGger:LEVel 0.2", 1)               ' Trigger level = 0.2 V
'The TRIGger:LEVel command also switches level peak-peak off.
CALL Send(0, 8, "TRIGger:SLOPe NEGative", 1)          ' Trigger slope = negative
CALL Send(0, 8, "INITiate", 1)                        ' Single initiation
CALL Send(0, 8, "FETCh:PTPeak? (@2)", 1)              ' Queries for peak-to-peak
response$ = "                    "
CALL Receive(0, 8, response$, 256)                    ' Enters peak-to-peak
PRINT "Measured peak-to-peak = "; response$           ' Prints peak-to-peak
```

Trigger Coupling

The TRIGger:LPASs and TRIGger:HPASs commands allow you to select the Main Time Base (MTB) trigger coupling by programming a fixed cutoff frequency. The possible trigger coupling options *AC coupling*, *DC coupling*, *Low Frequency reject*, and *High Frequency reject* are mutually exclusive. The TRIGger:LPASs and TRIGger:HPASs commands are also mutually exclusive. So, activating the Low-Pass filter will switch off the High-Pass filter, and vice versa. After a *RST command, the cutoff frequency is 10 Hertz, which selects trigger coupling AC.

Note: *When the trigger source is INTernal<n>, signal coupling for one input channel (n) can be programmed to AC, DC, or GROund using the INPut<n>:COUPling command.*

DC COUPLING (0 Hz cutoff frequency):



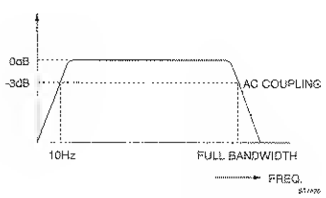
DC coupling causes the signal to be passed over the full bandwidth (from 0 Hz to 100/200 MHz).

Figure 3.4 DC Coupling

PROGRAM EXAMPLE:

```
***
*** Select DC coupling on input signal channel 2.
SENSe:FUNCtion:ON "XTIMe:VOLTage2"      Sets CH2 on.
INPut2:COUPling DC                      Sets CH2 input signal DC coupled.
TRIGger:SOURce INTernal2                Sets trigger source = CH2.
***
*** Select DC coupling on MTB triggering.
TRIGger:FILTer:LPASs:STATe ON           Sets Low-Pass filter on + cutoff frequency = 0 Hz;
                                        this selects MTB trigger DC coupling.
```

AC COUPLING (10 Hz cutoff frequency):



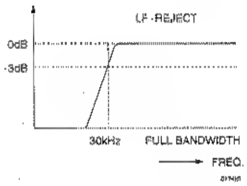
AC coupling causes the signal to be passed from 10 Hz to the full bandwidth frequency (100/200 MHz).

Figure 3.5 AC Coupling

PROGRAM EXAMPLE:

```
***
*** Select AC coupling on input signal channel 3.
SENSe:FUNCtion:ON "XTIMe:VOLTage3"      Sets CH3 on.
INPut3:COUPling AC                      Sets CH3 input signal AC coupled.
TRIGger:SOURce INTernal3                Sets trigger source = CH3.
***
*** Select AC coupling on MTB triggering.
TRIGger:FILTer:LPASs:STATe ON           Sets Low-Pass filter on + cutoff frequency = 0 Hz;
                                        this selects MTB trigger DC coupling.
TRIGger:FILTer:LPASs:FREQuency 10       Sets cutoff frequency = 10 Hz; this selects
                                        MTB trigger AC coupling.
```

LF-REJECT (30 KHz cutoff frequency):



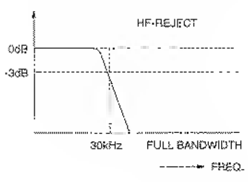
LF reject (HF passed) causes the signal to be passed from the cutoff frequency (30 KHz) to the full bandwidth frequency (100/200 MHz).

Figure 3.6 LF Reject

PROGRAM EXAMPLE:

`TRIGger:FILTer:LPASs:STATe ON`	Sets Low-Pass filter on + cutoff frequency = 0 Hz (DC coupling).
`TRIGger:FILTer:LPASs:FREQuency 3E+4`	Sets cutoff frequency = 30 KHz; this selects MTB trigger LF-reject.

HF-REJECT (30 KHz cutoff frequency)



HF reject (LF passed) causes the signal to be passed from 0 Hz to the cutoff frequency (30 KHz).

Figure 3.7 HF Reject

PROGRAM EXAMPLE:

```
***
*** Select HF-reject on MTB triggering.
TRIGger:FILTer:HPASs:STATe ON
```

Sets High-Pass filter on; this selects MTB trigger HF-reject.

3.4.1.2 Video triggering

TV video triggering enables stable triggering on video frames and lines from various TV standards without adjusting the trigger level, and can be selected by programming TRIGger:TYPE VIDeo.

Video triggering can be programmed on signals with a positive or negative signal polarity using the TRIGger:VIDeo:SSIGnal command.

The video trigger mode can be programmed to field1, field2, or lines using the TRIGger:VIDeo:FIELd... commands. The video trigger line can be programmed using the TRIGger:VIDeo:LINE commend.

The video system can be selected using the TRIGger:VIDeo:FORMat:... commands. The following standard video systems are supported:
- NTSC : 525 lines per frame
- PAL : 625 lines per freme
- SECAM : 625 lines per frame
- HDTV : 1050/1125/1250 lines per frame

1) Select video triggering and video standard.
   Examples: TRIGger:TYPE VIDeo
   Selects *TV video* triggering.
   TRIGger:VIDeo:FORMat:TYPE SECAM
   Selects the *SECAM* standard with 625 lines per frame.
   TRIGger:VIDeo:FORMat:LPFRame 1125
   Selects the *HDTV* standard with *1125* lines per frame.

2) Select video "lines" triggering and program the line to trigger on.
   Examples: TRIGger:VIDeo:FIELd:SELect ALL
   Selects the video *lines* trigger mode.
   TRIGger:VIDeo:LINE 512
   Selects video line number *512*.

3) Select video "field1/2" triggering and program the line to trigger on.
   Examples: TRIGger:VIDeo:FIELd:SELect NUMBer
   Selects video *field* triggering.
   TRIGger:VIDeo:FIELd:NUMBer 2
   Selects the video *field2* trigger mode.
   TRIGger:VIDeo:FORMat:TYPE PAL
   Selects the *PAL* standard with 625 lines per frame.
   TRIGger:VIDeo:LINE 123
   Selects video line number *123*. As a result the video mode is automatically switched to *field1* (field1 = lines 1 .. 312).
   TRIGger:VIDeo:LINE 325
   Selects video line number *325*. As a result the video mode is eutomatically switched to *field2* (field2 = lines 313 .. 625).
   TRIGger:VIDeo:FIELd:NUMBer 1
   Selects the video *field1* trigger mode. As a result the video line number is autometically switched to *13* (= 325 - 625/2).

3.4.1.3 *The trigger modes*

A combination of the INITiate:CONTinuous and TRIGger:SOURce command allows you to define the following trigger modes:

Trigger mode:	INITiate :CONTinuous	TRIGger :SOURce
>>>Single-shot<<< Generates one sweep, regardless of any trigger settings (valid after *RST).	OFF	IMMediate
>>>Single-shot<<< Generates one sweep, triggered using trigger settings.	OFF	INTernal<n> or LINE
>>> Single-shot <<< Generates one sweep, externally triggered via channel 4 (only for PM33x0A).	OFF	EXTernal
>>>Auto trig<<< Generates continuous sweeps, independent of any trigger settings.	ON	IMMediate
>>>Normal trig<<< Generates continuous sweeps, triggered using trigger settings.	ON	INTernal<n> or LINE
>>> Normal trig <<< Generates continuous sweeps, externally triggered via channel 4 (only for PM33x0A).	ON	EXTernal
>>>Single-Shot<<< Generates one sweep triggered by *TRG or GET, regardless of any trigger settings.	ON or OFF	BUS

Table 3.1 The TRIGger modes

Only in the single-shot and multiple-shot trigger mode (INITiate:CONTinuous OFF), the bits 3 (SWEeping) and 5 (Waiting for TRIGger) in the OPERation status are valid. Also the Operation Complete bit (OPC bit 0) in the standard Event Status Register (ESR) is valid. This allows you to detect whether the instrument is armed (initieted), triggered (busy with ecquisition), or finished with the lest acquisition, i.e., ready for the next ecquisition.

SINGLE-SHOT MODE (TB MODE - single):

Commands: CONFigure:AC — Configures instrument and sets single-shot mode.

STATE DESCRIPTION:	OPERATION STATUS BITS: bit 5 Wait for TRIG	bit 3 SWEeping	OPC	
idle state (after *RST)	0	0	0	
Wait for trigger state (INIT received)	1	0	0	= armed
Wait for complete (triggered)	1	0	0	or busy
Finished with acquisition	0	0	1	= ready

MULTIPLE-SHOT MODE (TB MODE - multi):

STATE DESCRIPTION:	OPERATION STATUS BITS: bit 5 Wait for TRIG	bit 3 SWEeping	OPC	
idle state (after *RST)	0	0	0	
Wait for trigger state (INIT received)	1	0	0	= armed
Wait for complete (triggered)	0	1	0	= busy
Finished with acquisition	0	0	1	= ready

The bits 3 (SWEeping) and 5 (Waiting for TRIGger) also reflect the acquisition status, when the "SINGLE ARM'D" button on the front panel was pressed.

Commands:		
	SYSTem:KEY 101	Performs AutoSet.
	DISPlay:MENU TBMode	Displays TBMODE menu.
	SYSTem:KEY 1	Sets INIT:CONT OFF and sets multiple-shot mode.

3.4.1.4 Pre- and post-triggering

When pre-triggering is selected, the reel trace acquisition begins before the moment that the trigger occurs. Triggering occurs when the trigger conditions are satisfied and the instrument leaves the "Wait for TRIGger" stete as shown in the trigger diagram of figure 3.3. In e similar wey, post-triggering causes the ecquisition to begin after the moment that the trigger occurs.

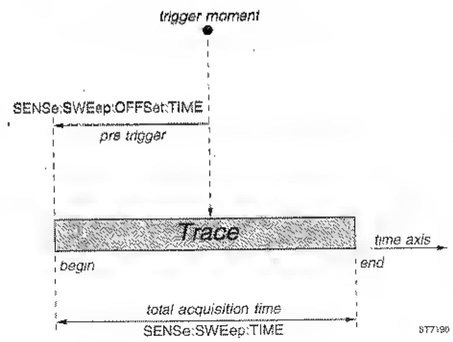


Figure 3.8 Pre-triggering

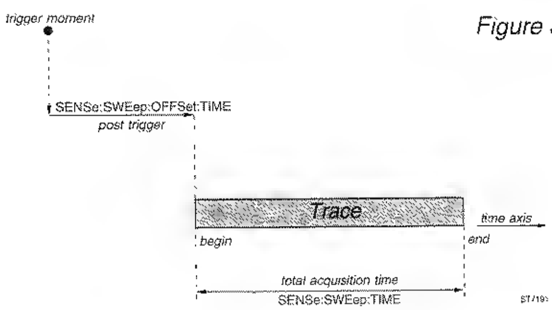


Figure 3.9 Post-triggering

Pre- and post-triggering are programmed with the SENSe:SWEep:OFFSet:TIME command. A positive parameter value specifies a post-trigger delay, whereas, a negative value results in e pre-trigger view.

After *RST, the SENSe:SWEep:OFFSet:TIME is set to -0.005, which results in e pre-trigger view of 5 ms. Because the *RST velue of the total acquisition time (SENSe:SWEep:TIME) is 10 ms, the trigger point is positioned in the middle of the trace.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "SENSe:SWEep:OFFSet:TIME 0.001", 1)   ' 1 ms post-trigger
CALL Send(0, 8, "SENSe:SWEep:OFFSet:TIME -1E-3", 1)   ' 1 ms pre-trigger
```

3.4.1.5 External triggering

External triggering is only possible for the PM33x0A CombiScope Instruments. Channel 4 is used as the external trigger channel with the following view possibilities:

- attenuator positions 0.1 and 1 V/div (AMP key).
- trigger slope positive or negative (EXT TRIG key).
- trigger coupling AC or DC (AC/DC key).

The view facility of the external trigger channel is switched on by sending the SENSe:FUNCtion:ON "XTIMe:VOLTage4" command, or by sending the SYSTem:KEY 812 command to simulate the pressing of the TRIG VIEW key on the front panel.

Note: The view facility of the external trigger channel can only be switched on when:

- *EXTernal or INTernal4 (CH4) is programmed as the trigger source.*
- *Peak detection is off.*

Autoset scans for the presence of a signal on channel 1, 2, and the external trigger input. If there is a signal present on the external trigger input, the EXTernal trigger channel is selected as trigger source, and the external trigger view facility becomes active.

Limitation: The amplitude of the external trigger signal must be high enough for the sensitivity of the external trigger input (0.1 or 1 V/div.).

3.4.2 Reading trace acquisitions

Once acquisitions ere completed, the resulting treces ares placed in TRACe memory, es shown in the following figure.

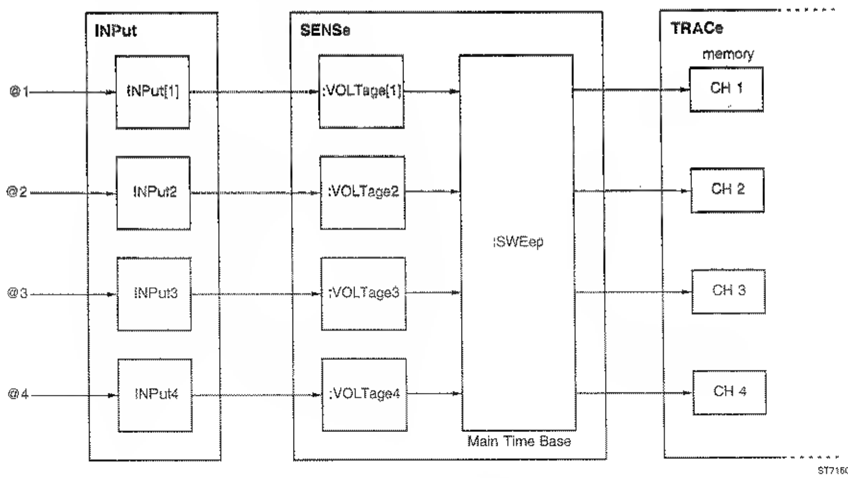


Figure 3.10 The trace acquisition flow

The last acquired trace at input channel 1 is placed in the TRACe memory element named CH1. The trace acquired at channel 2 in CH2, etc. This trace data can be read by using the TRACe[:DATA]? query.

Example:

TRACe? CH2 Returns the trace that was last acquired at input channel 2.

When new acquisitions are executed, the previously stored traces are not automatically saved, but overwritten by the new result. When these traces need to be saved, they have to be copied into other TRACe memory elements, before a new acquisition is initiated. Refer to section 3.10.2 "Copying traces to memory" for a description about how to copy traces.

As response to the TRACe? query the deta is returned as block date. Section 3.4.3 "Conversion of trace deta" specifies the coding of this dete end describes how to convert this data into voltage values.

3.4.2.1 *Single-shot acquisition*

PROGRAM EXAMPLE:

In this example a single-shot trace acquisition is done via channel 1. The trace bytes are entered as characters in the string response$.

```
DIM response AS STRING * 1033              ' Dimensions trace buffer
CALL Send(0, 8, "*RST", 1)                 ' Resets the instrument
                                           ' Trigger source becomes IMMediate
                                           ' Number of trace samples becomes 512
                                           ' Number of trace sample bits becomes 16
CALL Send(0, 8, "CONFigure:AC", 1)         ' Configures for optimal AC-RMS settings
CALL Send(0, 8, "INITiate", 1)             ' Initiates single acquisition
CALL Send(0, 8, "*WAI;TRACe? CH1", 1)      ' Requests for channel 1 trace data
'
' Notice the *WAI; before TRACe?. The *WAI command takes care that the
' TRACe? CH1 command is executed when the INITiate command is finished.
'
CALL Receive(0, 8, response$, 256)         ' Reads the channel 1 trace data
```

3.4.2.2 *Repetitive acquisitions*

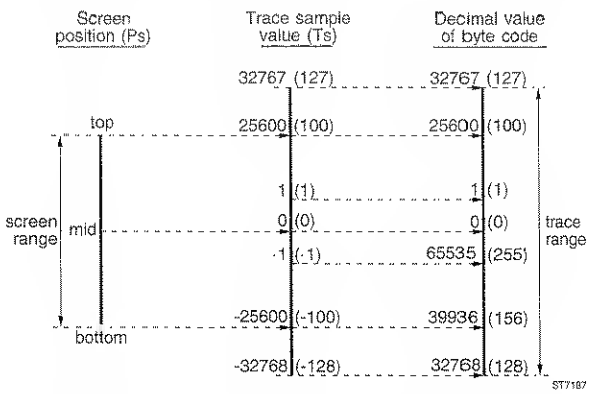
PROGRAM EXAMPLE:

In this example 10 trace acquisitions are done via channel 1. The trace bytes are entered as characters in the string response$. The 10 trace buffers are written to the file TRACE10 on the hard disk. Triggering is done via the GPIB by sending the *TRG command.

```
DIM response AS STRING * 1033                  ' Dimensions trace buffer
CALL Send(0, 8, "*RST", 1)                     ' Resets the instrument
                                               ' Trigger source becomes IMMediate
                                               ' Number of trace samples becomes 512
                                               ' Number of trace sample bits becomes 16
CALL Send(0, 8, "CONFigure:AC (@1)", 1)        ' Configures for optimal AC-RMS settings.
CALL Send(0, 8, "TRIGger:SOURce BUS", 1)       ' Trigger source = GPIB
OPEN "O",#1,"TRACE10"                          ' Opens file TRACE10
FOR i=1 TO 10                                  ' 10 sequential trace acquisitions
  CALL Send(0, 8, "INITiate", 1)               ' Initiates an acquisition
  CALL Send(0, 8, "*TRG", 1)                   ' Triggers via the GPIB
  CALL Send(0, 8, "*WAI;TRACe? CH1", 1)        ' Requests for channel 1 trace
  '
  ' Notice the *WAI; before TRACe?. The *WAI command takes care that
  ' the TRACe? CH1 command is executed when the INITiate command is finished.
  '
  CALL Receive(0, 8, response$, 256)           ' Reads the channel 1 trace
  PRINT #1, response$                          ' Writes the trace buffer to file
NEXT i                                         ' Next trace acquisition
CLOSE                                          ' Closes file TRACE10
```

3.4.3 Conversion of trace data

The trece dete is sent as a block of binary codes. Trace samples can be formatted to consist of 8 bits (1 byte) or 16 bits (2 bytes) codes, which cen be selected by the FORMet command. Refer to section 3.10.1 "Trace formatting" for a further explanation of this command. After *RST the samples are sent es 2 byte codes. When semples ere formetted as two bytes, the most significant byte (msb) is sent first, followed by the least significent byte (lsb). The semple velues that are sent in the block, are coded according to the two's complement notation. The relation between the screen positions, the values of the trace samples and the decimal value of the corresponding binary codes, is shown in the figure below.



Note: Numbers between parenthesis apply to single byte format.

Figure 3.11 Relation between screen position and trace value

The value of the trace points relate to the vertical position of the corresponding sample on the screen of the CombiScope instrument. As the figure above shows, the sample with value 25600 corresponds with the top position of the screen. Similarly, the samples with values -25600 and 0 correspond to the bottom and mid-position respectively. This applies to trace samples that are formatted to consist of 16 bits (2 bytes). The values that apply to the 8 bit (1 byte) format ere placed between parenthesis.

The ADC allows trace ecquisitions that ere somewhat outside the vertical screen boundaries. Trace acquisitions use the full dynamic renge of the ADC. This results in e dynemic trece range of 65535 points, wherees the screen range is limited to 51200 points.

3.4.3.1 Conversion of 8-bit samples to integer

As an example a conversion of a trace of 512 "8-bit" samples is shown. The format is as follows:

trace bytes

3 5 1 4 <8> <byte 1> . . . <byte 512> <checksum> <NL>

- <byte 512>: trace sample 512
- <byte 1>: trace sample 1
- <8>: byte with decimal value 8
- 5 1 4: number of trace bytes (514)
- 3: number of digits of 514

PROGRAM EXAMPLE:

In this example a trace acquisition of 1 byte samples is done. Thereafter, the trace data is read and converted to integer samples in the array "trace", and the number of trace bytes and trace samples is printed. The conversion from single byte value to integer is done as follows (refer to figure 3.12):
If byte ≥ 128 then integer = byte - 256.
Example: byte = 255 --> integer = 255 - 256 = -1.

```
DIM trace(512)                                   ' Array of 512 integers
DIM response AS STRING * 520                     ' Trace response buffer
CALL Send(0, 8, "*RST", 1)                       ' Resets the instrument
CALL Send(0, 8, "FORMat INTeger,8", 1)           ' Data format of 8-bits samples
CALL Send(0, 8, "INITiate", 1)                   ' Single shot initiation
CALL Send(0, 8, "*WAI;TRACe? CH1", 1)            ' Queries for channel 1 trace
CALL Receive(0, 8, response$, 256)               ' Reads the channel 1 trace
PRINT "Number of read bytes ="; IBCNT%           ' IBCNT% = number of read bytes
'
' The contents of the response$ string of this example will be as follows:
' # 3 5 1 4 <8> <byte 1> ... <byte 512> <checksum> <10>   '<10> is terminating LF
'
nr.of.digits = VAL(MID$(response$, 2, 1))
nr.of.bytes = VAL(MID$(response$, 3, nr.of.digits)) - 2
PRINT "Number of trace bytes ="; nr.of.bytes
sample.length = ASC(MID$(response$, 3 + nr.of.digits, 1))
nr.of.samples = nr.of.bytes / (sample.length / 8)
PRINT "Number of trace samples ="; nr.of.samples

FOR i = 1 TO nr.of.samples
  trace(i) = ASC(MID$(response$, i + 3 + nr.of.digits, 1))
  IF trace(i) > 127 THEN
    trace(i) = trace(i) - 256
  END IF
NEXT i
```

3.4.3.2 *Conversion of 16-bit samples to integer*

As an example a conversion of a trace of 512 "16-bit" samples is shown. The format is as follows:

trace bytes

4 1 0 2 6 <16> <msb 1> <lsb 1> . . . <msb 512> <lsb 512> <checksum> <NL>

- trace sample 512
- trace sample 1
- byte with decimal value 16
- number of trace bytes (1026)
- number of digits of 1026

PROGRAM EXAMPLE:

In this example a trace acquisition of 2 byte samples is done. Thereafter, the trace data is read and converted to integer samples in the array "trace", and the number of trace bytes samples is printed. The conversion from double byte (byte1 = msb and byte2 = lsb) to integer is done as follows (refer to figure 3.12):
If byte1 < 128 then integer = byte1 * 256 + byte2.
If byte1 ≥ 128 then integer = (byte1 - 256) * 256 + byte2.
Example: byte1 = 255 & byte2 = 32 --> integer = (255 - 256) * 256 + 32 = - 224.

```
DIM trace(512)                                  ' Array of 512 integers
DIM response AS STRING * 1033                   ' Trace response buffer
CALL Send(0, 8, "*RST", 1)                      ' Resets the instrument
                                                ' Sets 16 bit sample data format
CALL Send(0, 8, "INITiate", 1)                  ' Single shot initiation
CALL Send(0, 8, "*WAI;TRACe? CH1", 1)           ' Queries for channel 1 trace
CALL Receive(0, 8, response$, 256)              ' Reads the channel 1 trace
PRINT "Number of trace bytes ="; IBCNT%         ' IBCNT% = length of trace buffer
'
' The contents of the response$ string of this example will be as follows:
' # 4 1 0 2 6 <16> <msb1> <lsb1> ... <msb512> <lsb512> <sum> <10>
'
nr.of.digits = VAL(MID$(response$, 2, 1))
nr.of.bytes = VAL(MID$(response$, 3, nr.of.digits)) - 2
PRINT "Number of trace bytes ="; nr.of.bytes
sample.length = ASC(MID$(response$, 3 + nr.of.digits, 1))
nr.of.samples = nr.of.bytes / (sample.length / 8)
PRINT "Number of trace samples ="; nr.of.samples
FOR i = 1 TO nr.of.samples
  J = 2 * i + 2 + nr.of.digits                  ' Pointer to next sample
  byte1 = ASC(MID$(response$, J, 1))            ' Most Significant Byte
  byte2 = ASC(MID$(response$, J + 1, 1))        ' Least Significant Byte
  IF byte1 < 128 THEN
    trace(i) = byte1 * 256 + byte2
  ELSE trace(i) = (byte1 - 256) * 256 + byte2
  END IF
NEXT i
```

3.4.3.3 Conversion to voltage values

Screen positions correspond to voltage values. This relation is shown in the figure below, and is determined by the settings that are programmed by the SENSe:VOLTage:RANGe:PTPeak and SENSe:VOLTage:RANGe:OFFSet commands.

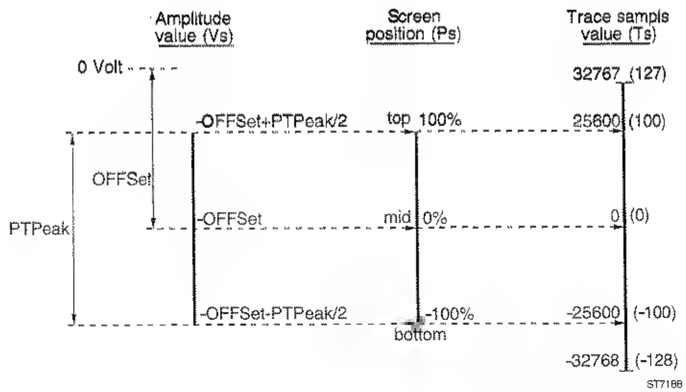


Figure 3.12 Relation between screen position and amplitude value

The relation between the screen position Ps and the corresponding voltage amplitude Vs is expressed by the equations:

Vs = (Ps * PTPeak) / 200 - OFFSet (for 8-bit sample traces)
Vs = (Ps * PTPeak) / 51200 - OFFSet (for 16-bit sample traces)

As explained in section 3.4.3, there is also a relation between the screen position Ps and the value Ts of a trace sample. This relation is expressed by the equations:

Ps = Ts (for 8-bit sample traces)
Ps = (Ts / 25600) * 100 = Ts / 256 (for 16-bit sample traces)

Eliminating Ps from the preceding equations results in a relation that can be used to calculate the voltage value Vs from a trace sample Ts. This relation is expressed by the equations:

Vs = (Ts / 200) * PTPeak - OFFSet (for 8-bit sample traces)
Vs = (Ts / 51200) * PTPeak - OFFSet (for 16-bit sample traces)

PROGRAM EXAMPLE:

In this program example a trace of 512 samples from the actual signal at input channel 1 is read. The received data block is converted to an array of voltages. After each sample conversion the voltage value is printed. This program example works for traces of 512 samples, consisting of 8 bits (1 byte) or 16 bits (2 bytes) samples.

Note: The program is supplied on floppy under file name EXCNVTRC.BAS.

```
DIM sample(512)                                    ' Array of sample voltages
DIM response AS STRING * 1033                      ' Trace data response string
DIM peaktop AS STRING * 10                         ' Peak-to-peak response string
DIM offs AS STRING * 10                            ' Offset response string
'
CALL Send(0, 8, "*RST", 1)                         ' Resets the instrument
CALL Send(0, 8, "CONFigure:AC (@1)", 1)            ' Configures for optimal AC-RMS settings
                                                   ' Signal-offset also becomes zero
CALL Send(0, 8, "INITiate", 1)                     ' Initiates single acquisition
CALL Send(0, 8, "*WAI;TRACe? CH1", 1)              ' Requests channel 1 trace
CALL Receive(0, 8, response$, 256)                 ' Reads channel 1 trace
'
nr.of.digits = VAL(MID$(response$, 2, 1))
nr.of.bytes = VAL(MID$(response$, 3, nr.of.digits)) - 2
sample.length = ASC(MID$(response$, 3 + nr.of.digits, 1))
nr.of.samples = nr.of.bytes / (sample.length / 8)
CALL Send(0, 8, "SENSe:VOLTage:RANGe:PTPeak?", 1)      ' Queries ptp
CALL Receive(0, 8, peaktop$, 256)                      ' Reads ptp
ptpeak = VAL(LEFT$(peaktop$, IBCNT%))                  ' IBCNT% = length
CALL Send(0, 8, "SENSe:VOLTage:RANGe:OFFSet?", 1)      ' Queries offset
CALL Receive(0, 8, offs$, 256)                         ' Reads offset
offset = VAL(LEFT$(offs$, IBCNT%))                     ' IBCNT% = length
IF sample.length = 1 THEN
  FOR i = 1 TO nr.of.samples                           ' 1-byte samples
    trace% = ASC(MID$(response$, i + 3 + nr.of.digits, 1))
    IF trace% > 127 THEN trace% = trace% - 256
    END IF
    sample(i) = trace% / 200 * ptpeak - offset
    PRINT sample(i);
  NEXT i
ELSE
  FOR i = 1 TO nr.of.samples                           ' 2-byte samples
    J = 2 * i + 2 + nr.of.digits                       ' Pointer to next sample
    byte1 = ASC(MID$(response$, J, 1))                 ' M.S.B.
    byte2 = ASC(MID$(response$, J + 1, 1))             ' L.S.B.
    IF byte1 < 128 THEN trace% = byte1 * 256 + byte2
    ELSE trace% = (byte1 - 256) * 256 + byte2
    END IF
    sample(i) = trace% / 51200 * ptpeak - offset
    PRINT sample(i);
  NEXT i
END IF
```

3.5 Averaging Acquisition Data

Acquired traces and measured signal characteristics can be averaged over a number of acquisitions. The preprocessing AVERAGE function of the CombiScopes instruments can be enabled by using the SENSe:AVERage[STATe] command. When this function is set to ON, averaging is done according to the following formula:

$$AVG_n = \sum (X_1 + .. + X_n)/n$$

In the expression, **n** specifies the number of acquisitions that is averaged. This parameter can be programmed by using the SENSe:AVERage:COUNt command. **X** represents the acquisition result to be averaged.

Example:

Send → SENSe:AVERage:COUnt 16 ' This sets the average count factor at 16, which means 16 sequential acquisitions are averaged.

Send → SENSe:AVERage ON ' This enables the AVERAGE function.

When SENSe:AVERage is set to ON and an acquisition is initiated, the CombiScope instrument takes n (SENSe:AVERage:COUNt) successive acquisitions, as shown in the figure on the next page. When sufficient acquisitions are taken, the final averaged result is returned. Intermediate results cannot be queried.

PROGRAM EXAMPLE:

Acquire the trace of the actual signal on channel 1 and measure the amplitude and frequency (averaged over 4 acquisitions).

```
DIM trace AS STRING * 1033                        ' Dimensions trace string
DIM amplitude AS STRING * 10                      ' Dimensions amplitude string
DIM frequency AS STRING * 10                      ' Dimensions frequency string
CALL Send(0, 8, "CONFigure:AC (@1)", 1)           ' Configures for AC-RMS
CALL Send(0, 8, "SENSe:AVERage:COUNt 4", 1)       ' Average factor = 4
CALL Send(0, 8, "SENSe:AVERage ON", 1)            ' Averaging is turned on
CALL Send(0, 8, "INITiate", 1)                    ' Initiates the averaging acquisition
CALL Send(0, 8, "*WAI;TRACe? CH1", 1)             ' Queries for channel 1 trace
CALL Receive(0, 8, trace$, 256)                   ' Enters channel 1 trace
' The trace samples are averaged over 4 sequential trace acquisitions.
CALL Send(0, 8, "READ:AMPLitude?", 1)             ' Reads the amplitude
CALL Receive(0, 8, amplitude$, 256)               ' Enters the amplitude
CALL Send(0, 8, "FETCh:FREQuency?", 1)            ' Fetches the frequency
CALL Receive(0, 8, frequency$, 256)               ' Enters the frequency
' The amplitude and frequency are averaged over 4 sequential measured values.
```

The following diagram shows the possible states of the acquisition process when "averaging" is on, and the way they are affected by commands.

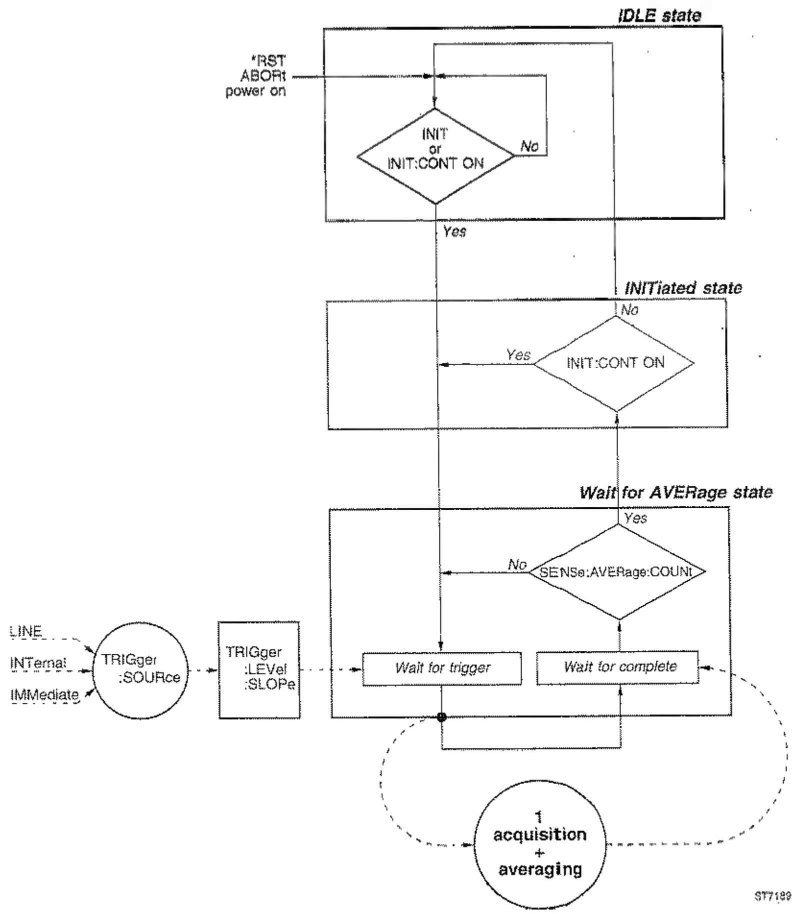


Figure 3.13 The Trigger Model during acquisition averaging

3.6 Channel Selection

Input channels can be switched on or off by using the SENSe:FUNCtion[:ON] or SENSa:FUNCtion:OFF commands. An input channal is selected by specifying tha parameter "XTIMe:VOLTage<n>", where the numeric suffix <n> spacifies tha input channel numbar. After a *RST command, channel 1 is turned on and the othar channels off (including the EXTernal input for PM33x0A).

Addition of two channals can be selected by specifying tha "XTIMe:VOLTage:SUM" parameter as follows:

> Addition of CH1 and CH2: "XTIMe:VOLTaga:SUM 1,2"
> Addition of CH3 and CH4: "XTIMe:VOLTage:SUM 3,4"

Note: *Enabling of the addition of input channels (e.g. CH3+CH4), automatically switches channel 3 and channel 4 on. Disabling of the addition of two channels (e.g. CH3+CH4), automatically switches channel 3 and channel 4 off, provided at least one channel remains on.*

Programming tip:

If CH1+CH2 is on and CH3 and CH4 are off, CH1+CH2 cannot be programmed off by sending: SENSE:FUNCtion:OFF "XTIME:VOLTage:SUM 1,2"
Instead, send the command:
SENSe:FUNCtion:ON "XTIME:VOLTage2" 'Sets CH2 on

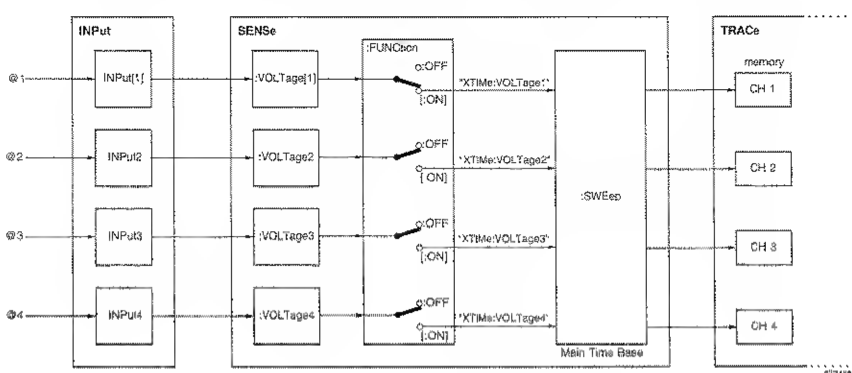


Figure 3.14 Input channel control

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage:SUM 1,2'", 1)
                                                    ' Sets CH1+CH2 on
CALL Send(0, 8, "SENSe:FUNCtion:ON 'XTIMe:VOLTage2'", 1)'
                                   'Sets CH2 on, CH1+CH2 off, CH1 remains off.
```

3.7 Signal Conditioning

The INPut subsystem allows you to condition the input signals, such as AC/DC/GROund coupling, input filtering, and input impedance selection.

In the digital mode, the SENSe:VOLTage<n>:RANGe:AUTO command allows you to enable autoranging of the attenuation for each of the input channels <n> separately.

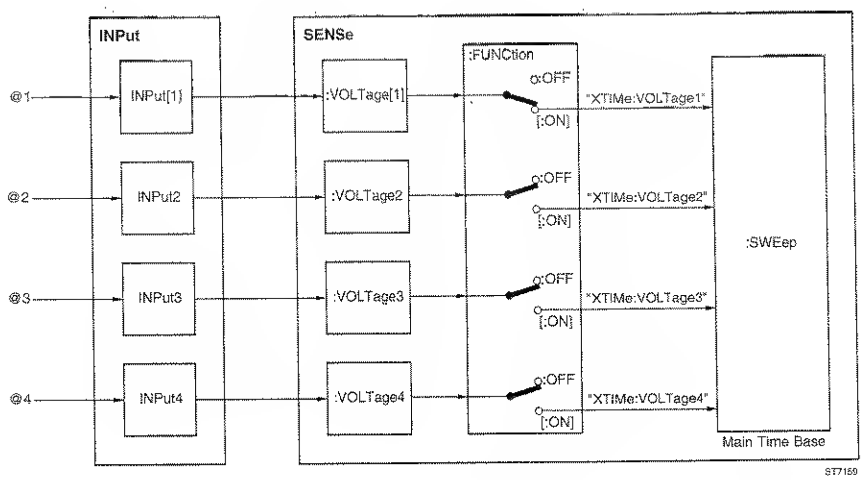


Figure 3.15 Signal conditioning

3.7.1 AC/DC/ground coupling

The INPut<n>:COUPling command allows you to set the vertical input coupling at AC, DC, or GROund for each input channel separately. After a *RST command, all input channels are **DC** coupled.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INPut:COUPling AC", 1)          ' Sets channel 1 AC coupled
CALL Send(0, 8, "INPut2:COUPling GROund", 1)     ' Sets channel 2 ground coupled
```

3.7.2 Input filtering

The INPut:FILTer command allows you to turn the common low-pass filter (bandwidth limiter) on or off for all input channels at the same time. The cutoff frequency is fixed at 20 MHz. After a *RST command, the filter is turned off.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INPut:FILTer ON", 1)                 'Turns the filter on
CALL Send(0, 8, "INPut:FILTer:FREQuency?", 1)  'Requests for the filter frequency
response$ = " "
CALL Receive(0, 8, response$, 256)                    'Reads the filter frequency
PRINT "Filter freq. = "; response$                    'Prints: Filter freq. = 2.00E+07
```

3.7.3 Input impedance

The INPut<n>:IMPedance command allows you to specify the input impedance low (50 Ω) or high (1 MΩ) for each input channel separately. After a *RST command, the impedance of each input channel is 1 MΩ.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INPut4:IMPedance 50", 1)   'Sets channel 4 impedance at 50Ω
```

3.7.4 Input polarity

The INPut<n>:POLarity command allows you to set the polarity of the signal on the input channel 2 and 4. The polarity can be set to NORMal (default) or INVerted (inverted signal).

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INPut2:POLarity NORMal", 1)     'Sets INV CH2 off
CALL Send(0, 8, "INPut4:POLarity INVerted", 1)   'Sets INV CH4 on
```

3.7.5 Vertical range and offset

The SENSe:VOLTage<n>:RANGe:PTPeak command allows you to specify the peak-to-peak range of the signal acquisition over all 8 divisions of the display screen for each input channel separately. From this peak-to-peak value the vertical sensitivity per division is calculated as follows:

<vertical_sensitivity> = <peak-to-peak> / 8.

After a *RST command, the peak-to-peak value is set at 1.6V for channel 1, which complies to a vertical sensitivity of 200 mV.

Because the programmed PTPeak and OFFSet values directly affect the trace values, they can be used to calculate the voltage amplitude of the corresponding trace samples. As explained in section 3.4.3.3 "Conversion to voltage values", the voltage amplitude of a trace sample can be calculated from the equations:

Vs = (Ts / 200) * PTPeak - OFFSet (for 8-bit sample traces)
Vs = (Ts / 51200) * PTPeak - OFFSet (for 16-bit sample traces)

where Ts = the value of the trace sample
and Vs = the corresponding voltage amplitude

The SENSe:VOLTage<n>:RANGe:OFFSet command allows you to specify the vertical offset for each input channel. After a *RST command, the vertical offset for each input channel is zero.

PROGRAM EXAMPLE:

```
CALL Send(0,8 "SENSe:VOLTage2:RANGe:PTPeak .8", 1)
' This sets the peak-to-peak range at 800 mV.
' So, the vertical sensitivity = 800 / 8 = 100 mV.
'
CALL Send(0,8 "SENSe:VOLTage2:RANGe:OFFSet .1", 1)
' This sets a positive vertical offset of 100 mV, i.e., 1 division.
```

3.7.6 Autoranging attenuators

The AUTO RANGE function automatically selects the vertical input sensitivity to keep the signal amplitude between 2 and 6.4 divisions on the screen. Autoranging attenuators work independently on the following acquisition channels:

> Input channel 1, 2, 3, and 4 for the PM33x4A CombiScope instruments.

> Input channel 1, and 2 for the PM33x2A CombiScope instruments.

Auto attenuation uses a peak-to-peak calculation to determine the maximum and minimum value of an acquisition, regardless of the input coupling. When auto attenuation is switched on for an input channel <n>, the input signal is automatically forced to AC coupling. Still, it is possible to switch to DC coupling by programming the INPut<n>:COUPling DC command. However, in that case, the proper operation cannot be guaranteed.

LIMITATION:

Auto attenuation is limited to 50 mV minimum per division. This minimum value is used as the noise level to prevent auto attenuation from trying to adjust noise on an open input channel.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INITiate:CONTinuous ON", 1)                  ' Auto triggering
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage2'", 1)         ' Sets CH2 on
CALL Send(0, 8, "SENSe:VOLTage2:RANGe:AUTO ON", 1)
' Sets auto attenuation for channel 2 ON and switches to AC signal coupling
```

3.8 Time Base Control

In the digital mode, the SENSe:SWEep:TIME:AUTO command allows you to enable autoranging of the main timebase (MTB).

3.8.1 Number of samples

The TRACe:POINts command allows you to set the number of sample points, which is the total acquisition length for all traces. The number of samples is limited to discrete values; refer to the TRACe:POINts command reference for a detailed specification of these values. After a *RST command, the number of samples is 512.

Note: *If the number of samples is changed, the contents of all trace memories is cleared. So, all previously stored traces are lost!*

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                        ' Acquisition length = 512 samples.
CALL Send(0, 8, "TRACe:POINts CH1,8192", 1)  ' Acquisition lengthd = 8192 samples.
```

3.8.2 Time base speed

The SENSe:SWEep:TIME command specifies the time base of a sweep, which is the time duration of one complete trace acquisition. Because the SENSe:SWEep:TIME values are limited in the digital mode by permitted MTB values, only particular values can be specified with this command. Refer to the SENSe:SWEep:TIME command reference for a detailed specification of these values.

Together with the number of trace points (TRACe:POINTs), the SENSe:SWEep:TIME command determines the Main Time Base (MTB). The MTB is expressed in seconds per division. Since there are 50 points in each division, the MTB can be calculated from the following equation:

MTB = 50 * SENSe:SWEep:TIME / (TRACe:POINts -1)

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "SENSe:SWEep:TIME?, 1)     ' Requests sweep time
CALL Receive(0, 8, STIME$, 256)            ' Reads sweep time
CALL Send(0, 8, "TRACe:POINts? CH1, 1)     ' Requests number of trace points
CALL Receive(0, 8, TPOINTS$, 256)          ' Reads number of trace points
SWETIM = VAL(STIME$)                       ' Converts string to variable
TRAPOI = VAL(TPOINTS$)                     ' Converts string to variable
MTB = 50 * SWETIM / (TRAPOI-1)             ' Calculates the MTB
PRINT "Main Time Base ="; MTB              ' Prints the MTB
```

In a similar way, the time value Ts that is associated with a trace sample point can be calculated from the following expression:

Ts = <sample_index> * SENSe:SWEep:TIME / (TRACe:POINts - 1)

where <sample_index> is the point number of the sample in the trace.

3.8.3 Real time acquisition

Since there is a physical limit to the maximum sample rate of the ADC, traces with a duration which is less than 200 ns cannot be sampled within one real-time acquisition. To allow you to go below the 200 ns limit, the CombiScope instrument uses particular random sampling techniques, where points in the requested trace are collected from a number of successive acquisitions. The result returned is a reconstruction of the original signal out of several acquisitions, which is not real time.

When real time acquisition needs to be guaranteed, the command SENSe:SWEep:REALtime[:STATe] must be set to ON. This disables the random sampling techniques. The trade-off is that the SENSe:SWEep:TIME range is limited to 200 ns. After *RST the :REALtime command is set to OFF.

The "peak detection" function allows the Analog-to-Digital Converters (ADC) to operate at their highest speed, even when a lower time base speed is selected. The result is that maximum and minimum peaks of the signal are detected, even at lower time base speeds. This is called oversampling. The SENSe:SWEep:PDETection[:STATe] command allows you to switch peak detection on or off.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                           ' Real time mode off
CALL Send(0, 8, "SENSe:SWEep:REALtime ON", 1)        ' Real time mode on
CALL Send(0, 8, "SENSe:SWEep:PDETection ON", 1)      ' Sets peak detection on.
```

3.8.4 Autoranging time base

The AUTO RANGE function of the Main Time Bese (MTB) edjusts the time base eutometically, so that two to six waveform periods are displayed on the screen. If a waveform doesn't contain enough information to calculate its period, the time bese is adjusted to acquire a minimum of two periods. One period of a signal is determined by three successive crossings of the hysteresis bend with the input signal. The level of the hysteresis bend cen be set using the TRIGger:LEVel command.

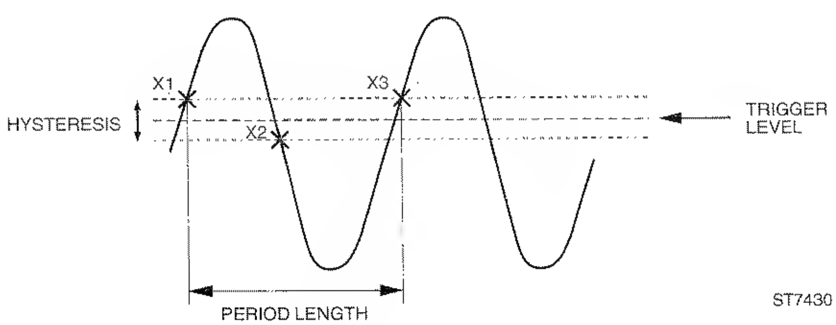


Figure 3.16 Definition of a signal period

LIMITATION:
When operating with an acquisition length of 512 points, the maximum input frequency is 25 MHz. For all other acquisition lengths, the maximum input frequency is 50 MHz. When the input frequency is greater than the maximum alias detection frequency, it is no longer possible to detect aliasing.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "INITiate:CONTinuous ON", 1)        ' Auto triggering
CALL Send(0, 8, "TRIGger:SOURce INTernal1", 1)      ' Sets CH1 trigger source
CALL Send(0, 8, "SENSe:SWEep:TIME:AUTO ON", 1)      ' Sets auto time base on
```

3.9 Post Processing

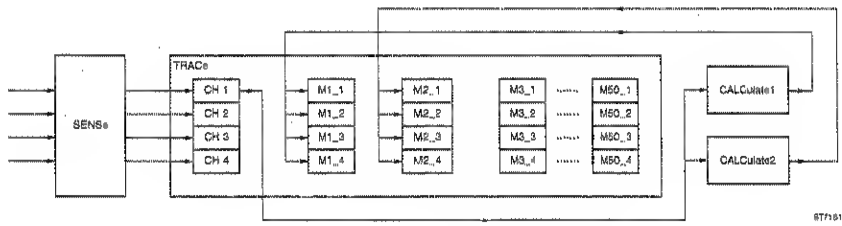


Figure 3.17 Post processing control

3.9.1 How to do post processing

The post processing functions CALCulate1 and CALCulate2 comply with the front panel functions MATH1 and MATH2 of the CombiScope instrument. They work only in the digital mode. The use of the CALCulate functions is as follows:

1 Select the source for the post processing function.
2 Specify the settings of the post processing function.
3 Enable the post processing function.
4 Check the result of the post processing function.

3.9.1.1 Select the source for the post processing function.

Select the trace that is to be sourced into the CALCulate function by sending the CALCulate<n>:FEED command.

Examples:
Send → CALCulate2:FEED "CH3" 'Channel 3 = source for CALC2
Send → CALCulate:FEED "M2_1" 'M2_1 = source for CALC1

Empty traces may not be selected as input trace. A memory register 1 location (M1_ j) may not be specified as the source (feed) for CALCulate1 and a memory register 2 location (M2_ j) may not be the source (feed) for CALCulate2. After a *RST command, CH1 becomes the input trace for both CALculate functions.

Note: CH3 and CH4 cannot be selected as source for the PM33x0A CombiScope instruments.

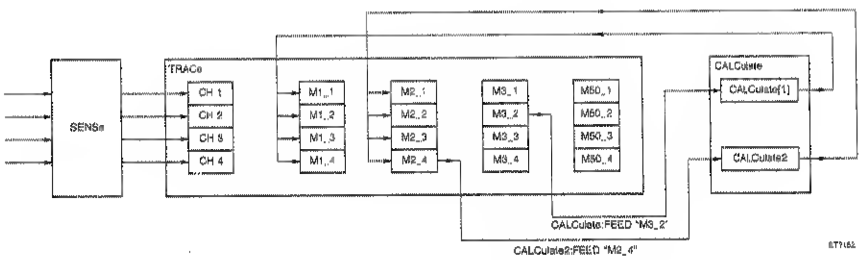


Figure 3.18 Post processing feed definition

3.9.1.2 Specify the settings of the post processing function.

When desired, specify the settings of the post processing function to be used. The following settings can be programmed:

- the filter type of the FFT function	RECTanguler I HAMMing I HANNing
- the width of the low-pass filter window	3, 5, 7, .., 39, 41 points
- the width of the differential window	3, 5, 7, .., 127, 129 points

Example:
Send → CALCulate2:TRANsform:FREQuency:WINDow HAMMing
'Defines the Hamming filter for the FFT process.

3.9.1.3 Enable the post processing function.

Enable the desired post processing function by using the :STATe command of the calculate function concerned. The following post processing functions are available:

STANDARD AVAILABLE:

- mathematical calculations	:MATH
- frequency filtering	:FILTer:FREOuency
- frequency domain transformations (FFT)	:TRANsform:FREOuency

OPTIONAL:

- histogram transformation	:TRANsform:HISTogram
- integrating traces	:INTegral
- differentiating traces	:DERIvetive (alias :DIFFerential)

Exemple:
Send → CALCulate2:TRANsform:FREQuency:STATe ON 'Enebles FFT

The post processing is autometically executed when a trace that is fed into the CALCulate function is changed. If a mathematical function is switched on, the other functions are autometicelly switched off.

3.9.1.4 Check the result of the post processing function.

The results of the post processing functions :MATH
:TRANSform:FREQuency
:TRANSform:HISTogram
are stored in M1_1 for CALCulate1 and in M2_1 for CALCulate2, regardless of the input (feed) trace.

The results of the post processing functions :FILTer:FREQuency
:INTegral
:DERivative (or :DIFFerential)
are stored in M1_n or M2_n, depending of the input source. When CHn or Mi_n is the input trace for CALCulate1, the result is placed in M1_n (n = 1, 2, 3, 4). When CHn or Mi_n is the input trace for CALCulate2, the result is placed in M2_n (n = 1, 2, 3, 4).

Example:
Send → CALCulate2:FEED "CH3"
Send → CALCulate2:INTegral:STATe ON
'The result is that the integral of the channel 3 trace is placed in M2_3.

When the result of a calculation is saved in a trace memory location, the other trace locations of the same memory register are used by the calculate process. Data stored in these locations may be destroyed. For example, a CALculate1 process that stores the result in M1_2, may also destroy the contents of M1_1, M1_3, and M1_4. The result of a CALCulate function that is stored in a trace memory can be read into the controller by using the TRACe? query.

Example:
Send → TRACe? M2_1 'Requests for M2_1 trace
Read ← <trace_buffer> 'Reads M2_1 trace

Note: The result of a CALCulate block can be used as source for the other CALCulate block, but not as source for the same CALCulate block.

PROGRAM EXAMPLE:

```
DIM response AS STRING * 1033                    ' Dimensions trace buffer
CALL Send(0, 8, "CALCulate2:FEED 'CH3'", 1)      ' Channel 3 = source CALC2
CALL Send(0, 8, "CALCulate2:TRANsform:FREQuency:WINDow HAMMing", 1)
CALL Send(0, 8, "CALCulate2:TRANsform:FREQuency:STATe ON", 1)
                                                 ' Enables FFT-Hamming
CALL Send(0, 8, "TRACe? M2_1", 1)                ' Requests for M2_1 trace
CALL Receive(0, 8, response$, 256)               ' Reads the M2_1 trace
```

3.9.2 Mathematical calculations

Mathematical calculations can be performed on 2 traces using the CALCulate1:MATH and CALCulate2:MATH functions. These functions comply with the front panel features MATH1 and MATH2 respectively. The calculation can be an addition (+), a subtraction (-), or a multiplication (*). The attenuation of the resulting trace is automatically set higher than the sum of the attenuations of the individual traces.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "CALCulate:MATH (CH1+CH2)", 1)          ' Channel 1 + channel 2
CALL Send(0, 8, "CALCulate:MATH:STATe ON", 1)           ' Math function enabled
' The resulting trace (CH1 + CH2) is stored in M1_1.
CALL Send(0, 8, "CALCulate2:MATH (M1_1 - CH2)", 1)      ' M1_1 - channel 2
' The resulting trace (which is the CH1 trace) is stored in M2_1.
```

The first argument in the expression that defines the mathematical operation to be performed, is a trace that may be specified either implicitly, or explicitly by its trace name. A trace is specified implicitly when the keyword IMPLied is used as argument in the expression. When IMPlied is specified, the trace that is programmed with the CALCulate:FEED command is used as the first argument in the expression. The trace that determines the second argument must always be specified explicitly by its trace name.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "CALCulate:FEED 'CH3'", 1)              ' Channel 3 = input source
CALL Send(0, 8, "CALCulate:MATH (IMPLied+CH2)", 1)      ' Channel 3 + channel 2
CALL Send(0, 8, "CALCulate:MATH:STATe ON", 1)           ' Math function enabled
' The resulting trace (CH3 + CH2) is stored in M1_1.
```

3.9.3 Differentiating and integrating traces

The INTegral function performs a point-to-point integration on a trace. The result of the integration process is a trace. Each point in the trace is the integral up to the corresponding point in the original (input) trace.

The DERivative (DIFFerential) function calculates the differential quotient of the trace points. Each point in the resulting trace is the derivative of the corresponding point in the original (input) trace. The width of the differential window can be programmed from 3 to 129 points in increments of 2 points by the CALCulate:DERivative:POINts command. After a *RST command, the number of points is 5.

Scaling can be adjusted with the "CURSQRS TRACK and delta" knobs via the MATHPLUS - PARAM menu option.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "CALCulate:INTegral:STATe ON", 1)      ' Integral CALC1 on
CALL Send(0, 8, "CALCulate2:DERivative:POINts 35", 1) ' 35 differential points
CALL Send(0, 8, "CALCulate2:DERivative:STATe ON", 1)  ' Differential CALC2 on
```

3.9.4 Frequency domain transformations

The result of an FFT (Fast Fourier Transformation) calculation is displayed as a trace of amplitude values (vertically) versus frequency values (horizontally). The vertical result can be expressed as a relative or an absolute amplitude value. The CALCulate:TRANsform:FREQuency:TYPE command selects between the RELative and ABSolute result. The DISPlay:WINDow:TEXT<n>:DATA? query allows you to read the calculated amplitude and frequency value.

RELATIVE FFT:

A relative FFT calculation consists of a frequency (Hz) and an amplitude in (dB), relative to the frequency component with the largest amplitude.

ABSOLUTE FFT:

An absolute FFT calculation consists of a frequency (Hz) and an amplitude in dBm (dB with respect to 1 milliwatt), dBµV (dB with respect to 1 microvolt), or Vrms (Volt RMS) as selected via the front panel CURSORS - READOUT softkey menu.

The following FFT window functions can be selected using the CALCulate:TRANsform:FREQuency:WINDow command:

- The FFT RECTangular function transforms a repetitive time amplitude trace into its power spectrum.
- The FFT HAMMing and HANNing functions reduce the side lobes by applying a Hamming respectively Hanning window to the input signal. This improves the visibility of the minor frequency components if the limited area is not accurately selected.

The resulting FFT trace is a MIN/MAX (envelope) trace, which means that each trace point is determined twice (one for the MINimum envelope and one for the MAXimum envelope). The FFT trace points are scaled between +4 and -4 divisions on the screen. So, the samples values that are returned as response to a TRACe? query ara shifted 4 divisions upwards. The values of the resulting FFT trace points are between -0 dB and -80 dB. This results in the following relation between screen position and sample value:

		Trace sample value 8-bits	16-bits	Trece point value	
screen range	top- - - - - -	100	25600	- 0 dB	trece renge
	- - - - - - - -	75	19200	- 10 dB	
	- - - - - - - -	50	12800	- 20 dB	
	- - - - - - - -	25	6400	- 30 dB	
	mid - - - - -	0	0	- 40 dB	
	- - - - - - - -	- 25	- 6400	- 50 dB	
	- - - - - - - -	- 50	- 12800	- 60 dB	
	- - - - - - - -	- 75	- 19200	- 70 dB	
	bottom - - -	- 100	- 25600	- 80 dB	

Figure 3.19 · Relation between screen position and FFT value

TRACE POINT VALUES:

FFT trace sample values, as entered with the TRACe:DATA? query, can be converted to FFT point value as follows:

- Subtract from the sample value the offset value for 4 divisions:
  - for 8-bit samples: 4 * 25 = 100
  - for 16-bit samples: 4 * 6400 = 25600
- Multiply the result with the following correction factor:
  - for 8-bit samples: -10(dB) / -25 = 0.4
  - for 16-bit samples: -10(dB) / -6400 = 0.0015625

So, the conversion from a trace sample value (Ts) to a trace point value (Ps) is expressed by the equations:

- for 8-bit samples: **Ps = (Ts - 100) * 0.4**
- for 16-bit samples: **Ps = (Ts - 25600) * 0.0015625**

Note: *For an explanation of Ts and Ps, refer to section 3.4.3 "Conversion of trace data".*

When relative FFT calculation is selected, the amplitude trace point values represent the relative strength of the frequency components. The component with the highest amplitude is taken es the reference level, referred to es the 0 dB level.

When absolute FFT celculation is selected, the emplitude trace point values depend on the ebsolute reference level as selected via the CURSORS - READOUT front panel menu, which cen be one of the following:

- dBm (reference = 1 mW) with REFerence IMPedence of 50Ω
- dBm (reference = 1 mW) with REFerence IMPedance of 600Ω
- dBµV (reference = 1 µV)
- Vrms (reference = RMS signel amplitude)

Absolute FFT amplitudes are calculated from the true signal using the information on the actual attenuator setting in the range from 5 V/div. to 2 mV/div. This results in an offset value to be added to the relative FFT amplitude for each attenuator setting. In any attenuator setting, the reference level for the absolute FFT value is calculated from a peak-to- peak amplitude of a sine wave on a screen of 6.34 divisions. This amplitude equals an RMS value of:

$$6.34/2\sqrt{2} \approx 2.24$$

This level is used as the reference level (top of screen) for the FFT amplitude display. For any attenuator setting, the reference level can be calculated as follows:

2.24 * <number of millivolts per divisions>

Examples: At 20mV/div. : 2.24 * 20 ≈ 44.8 mVrms
At 100mV/div.: 2.24 * 100 ≈ 224 mVrms

For a 50Ω system, a signal amplitude of 224 mVrms corresponds to the following signal power:

$$P = (0.224)^2/50 \approx 0.001\ W \approx 1\ mW$$

This can also be expressed as a signal level of 0dBm at 50Ω impedance.

The same voltage measured in a 600Ω system corresponds to the following power level:

$$P = (0.224)^2/600 \approx 0.0000836\ \mathrm{W} \approx 83.6\ \mu W$$

This can be calculated as a signal level of:

$$10 * {}^{10}\log(83.6\mathrm{E}\text{-}6/1\ \mathrm{mW}) = 10 * {}^{10}\log(83.6\mathrm{E}\text{-}3) \approx -10.7\ \mathrm{dBm}$$

Vrms offset calculation:

A signal of 1 mW at 50Ω impedance is taken as voltage reference at 100 mV/div. From this signal the RMS voltage is calculated as follows:

$$Urms = \sqrt{(P * R)} = \sqrt{(1\mathrm{E}\text{-}3 * 50)} = 0.2236068$$

For a whole screen of 10 divisions, **Urms = 2.236068**. Depending on the attenuator setting, the Vrms offset voltage is calculated as follows:

Vrms offset = attenuation * Urms

Example for attenuator setting 0.5 V/div.:

Vrms offset = 0.5 *2.236068 = 1.118034

dBm - 50Ω offset calculation:

From the Vrms offset value the dBm-50Ω offset value is calculated as follows:

$$dBm\text{–}50\Omega \text{ offset} = 20 * {}^{10}\log\,(\text{Vrms offset}/0.2236068)$$

Note: $\sqrt{(P * R)} = \sqrt{(1\text{E-}3 * 50)} = 0.2236068$

Example for attenuator setting 0.5 V/div.:

$$dBm\text{–}50\Omega \text{ offset} = 20 * {}^{10}\log\,(1.118034/0.2236068) = 13.9794$$

dBm - 600Ω offset calculation:

From the Vrms offset value the dBm-600Ω offset value is calculated as follows:

$$dBm\text{–}600\Omega \text{ offset} = 20 * {}^{10}\log\,(\text{Vrms offset}/0.7745967)$$

Note: $\sqrt{(P * R)} = \sqrt{(1\text{E-}3 * 600)} = 0.7745967$

Example for attenuator setting 0.5 V/div.:

$$dBm\text{–}600\Omega \text{ offset} = 20 * {}^{10}\log\,(1.118034/0.7745967) = 3.1875874$$

dBμV offset calculation:

From the Vrms offset value the dBμV offset value is calculated as follows:

$$dB\mu V \text{ offset} = 20 * {}^{10}\log\,(\text{Vrms offset}/1.0\text{E-}6)$$

Note: 0 dBμV = 1 μV (1.0E-6 V) at 50Ω impedance.

Example for attenuator setting 0.5 V/div.:

$$dB\mu V \text{ offset} = 20 * {}^{10}\log\,(1.118034/1\text{E-}6) = 120.9691$$

SUMMARY OF CALCULATED OFFSET VALUES:

ATTENUATOR SETTING:	Vrms:	dBm-50Ω:	dBm-600Ω:	dBμV:
5 V/div	+ 11.18034	+ 33.9794	+ 23.187588	+140.9691
2 "	+ 4.4721359	+ 26.0206	+ 15.228787	+133.0103
1 "	+ 2.236068	+ 20.0	+ 9.2081872	+126.9897
0.5 "	+ 1.118034	+ 13.9794	+ 3.1875874	+120.9691
0.2 "	+ 0.4472136	+ 6.0206	- 4.771213	+113.0103
0.1 "	+ 0.2236068	0.0	- 10.791813	+106.9897
50 mV/div	+ 0.1118034	- 6.0206	- 16.812413	+100.9691
20 "	+ 0.0447214	- 13.979392	- 24.771206	+ 93.010308
10 "	+ 0.0223607	- 20.0	- 30.791813	+ 86.989708
5 "	+ 0.0111803	- 26.020632	- 36.812444	+ 80.96907
2 "	+ 0.0044721	- 33.97947	- 44.771282	+ 73.01023

Note: *The PROGRAM EXAMPLE on the next page shows how it is programmed.*

TRACE POINT FREQUENCIES:

The horizontal frequency values (in Hz per point) are calculated from the trace sample index (point number of the sample in the trace), the acquisition length (TRACe:POINts), and the MTB (calculated from the SENSe:SWEep:TIME) by the following equation:

Fs = (<sample_index> * 1250) / (TRACe:POINts * MTB * 50)

Restriction: Only trace sample data can be queried from trace memories; no trace administration data, such as acquisition length and MTB value. This means that these values must be queried from the actual input channel signal, which is taken as the source for the FFT process. So, take care that the acquisition length nor the MTB is changed between activating the post processing function and reading the trace memory where the post processing trace is stored.

PROGRAM EXAMPLE:

The following program example converts a relative or absolute FFT trace of 512 samples of 1 or 2 bytes from the signal on channel 1 via the MATH1 feature as follows:

- Before running this program, first make the FFT selections desired via the front panel, such as:
  - > MATH - MATH1 "on" and "fft".
  - > CURSORS "on" and "m1.1".
  - > MATH - PARAM - FILTER "hamming", "hanning", or "rectang".
  - > MATH - PARAM - READOUT "rel" to select relative FFT.
  - > MATH - PARAM - READOUT "abs" to select absolute FFT.
    + CURSORS - READOUT "dBm + 50Ω", "dBm + 600Ω", "dBμV", or "Vrms".

- Request the following values:
  - > The acquisition length using the TRACe:POINts? CH1 query.
  - > The sweep time to calculate the MTB using the SENSe:SWEep:TIME? query.
    MTB = (sweep_time * 50) / (acquisition_length - 1).
    The calculation factor to determine the sample point frequencies is determined as follows:
    calc = 1250 / (acquisition_length * MTB * 50).
  - > The peak-to-peak voltage to calculate the attenuation using the SENSe:VOLTage:RANGe:PTPeak? query.
    Attenuation = peak-to=peak / 8.
  - > The FFT type, i.e., ABSolute or RELative, using the CALCulate:TRANsform:FREQuency:TYPE? query.

- Read the FFT trace from memory register m1.1 using the TRACe? M1_1 query.

- Convert and print the frequency and amplitude values of the FFT trace sample points according to the formulas as explained before.
  Note: *The program prints the calculated values in groups of 20 sample points on the screen of your computer.*

Note: *The program is supplied on floppy under file name EXFFTTRC.BAS.*

3.9.5 Histogram functions

The HISTogram function calculates an amplitude distribution of the incoming trace. The number of points in the histogram trace is 512. Each point in the histogram specifies the number of times that a data point of the incoming trace is within a particular amplitude belt. Since there are 512 histogram points, there are also 512 amplitude belts. The range of the amplitude belts is determined by the selected peak-to-peak range (SENSe:VOLTage:RANGe:PTPeak) and is expressed by the following equation:

amplitude belt = peak-to-peak range / 512

Notice that a histogram contains 512 valid data points. The number of points (TRACe:POINts) of the trace memory location where the histogram is stored, may exceed this value. In that case the values of the trace positions above 512 have to be ignored.

The histogram is displayed on the screen in the area between +3 and -2 divisions vertically, and between the third and the seventh division horizontally. The horizontal axis represents the amplitude in volts. The vertical axis represents the number of occurrences of an amplitude in percents.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "CALCulate:TRANsform:HISTogram:STATe ON", 1)
                                    'This turns the histogram function on.
```

3.9.6 Frequency filtering

The FILTer function performs digital low-pass filtering to suppress undesired frequency noise. The width of the filter window can be programmed from 3 to 41 points in increments of 2 points. After a *RST command, the number of points is 19.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "CALCulate:FILTer:FREQuency:POINts 35", 1)
                                    ' 35 filter points
CALL Send(0, 8, "CALCulate:FILTer:FREQuency:STATe ON", 1)
                                    ' Filter CALC1 on
```

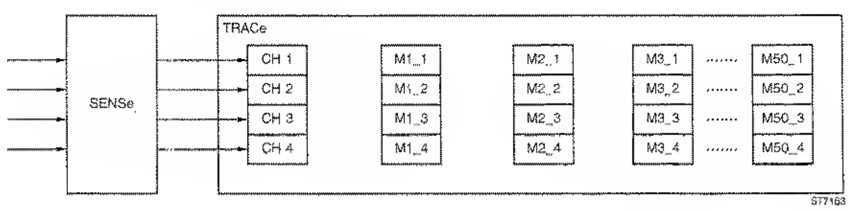
3.10 Trace Memory

The trace memory of the CombiScopes Instruments consists of space for channel acquisition traces (CH1 to CH4) and memory register traces (M1 to M8 and M9 to M50 extended). The amount of acquisition and register space depends on the following:

- Whether the CombiScope instrument is equipped with standard or with extended memory.
- The specified acquisition length (number of trace samples) with the TRACe:POINts command.

  Example:
  Send → TRACe:POINts CH1,8192
  This command specifies an acquisition length of 8192 samples for all traces.

Notes: - *Only the following trace acquisition lengths can be programmed: 512, 2024 (2K), 4096 (4K), 8192 (8K), 16384 (16K), or 32768 (32K)*
- *If a different acquisition length is programmed, the contents of all acquisition and register space is cleared. So, all previously stored traces are lost!*
- *After a *RST command, the number of trace samples is 512.*
- *The resulting traces of the post processing functions are always stored in memory register 1 for CALCulate1 functions and in memory register 2 for CALCulate2 functions.*



Note: *For standard memory, 8 memory registers are available (M1 to M8).*
For extended memory, 50 memory registers are available (M1 to M50).

Figure 3.20 Trece memory control

Note: *CH3 and CH4 cannot be selected as the source for the PM33x0A CombiScope instruments. Insteed the external channel cen be selected, e.g., M1_E.*

The following table shows the relation between the trace acquisition length (TRACe:POINts) and the available channel (CHx) and memory traces (Mx).

TRACe:POINts	CHANNELS:		MEMORY REGISTERS:
STANDARD:		(PM33x0A)	
512	4	(2+EXT)	M1 .. M8
2K	4	(2+EXT)	M1 .. M2
4K	2	(2)	M1 .. M2
8K	1	(none)	M1 .. M2
EXTENDED:		(PM33x0A)	
512	4	(2+EXT)	M1 .. M50
8k	4	(2+EXT)	M1 .. M2
16K	2	(2)	M1 .. M2
32K	1	(none)	M1 .. M2

Note: *Standard 8K or extended 32K not applicable for the PM33x0A CombiScope instruments.*

Examples:

- Standard memory 4K acquisition length allows, for example:
  CH1 + M1_1 + M2_1 + CH3 + M1_3 + M2_3
- Extended memory 32K acquisition length allows, for example:
  CH2 + M1_2 + M2_2

Table 3.2 Relation between acquisition length and available trace memory

Note: *Delayed Time Base (DTB) acquisition traces are only saved in the CH1 to CH4 memory, when the acquisition length is 512 samples. DTB acquisitions can only be defined via front panel operations.*

3.10.1 Trace formatting

The FORMat command allows you to format the resolution of trace sample values. The resolution is determined by specifying the number of bits used to code the sample values of all trace acquisitions. Trace samples can be programmed to be formatted as 16 bits (2 bytes) or as 8 bits (1 byte). After a *RST command, the number of trace sample bits is 16 (2 bytes). Notice that the contents of acquisition and register space is not cleared when a different trace format is programmed.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                  'Length of trace samples = 16 bits
CALL Send(0, 8, "FORMat INTeger,8", 1)      'Length of trace samples = 8 bits
```

3.10.2 Copying traces to memory

The TRACe:COPY command allows you to copy the contents of a memory register to another memory register. This allows you to fill a memory register with traces from one of the following sources:

- Copy an acquisition trace from one of the input channels.

  Example:
  Send → TRACe:COPY M1_2,CH2 ' Copies from CH2 to M1_2

  Note: The result of this command is also that the acquisition traces of other channels (CHn) are copied into M1_n, provided channel CHn is on. So, all previously stored traces in M1 are lost!

- Copy a previously stored trace from another trace memory register.

  Example:
  Send → TRACe:COPY M2_2,M1_2 ' Copies from M1_2 to M2_2

  Note: The result of this command is also that all stored traces of M2_N are copied into M1_n, provided a trace was stored before. So, all previously stored traces in M2 are lost!

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                                  ' Channel 1 on
                                                            ' Channel 2, 3, 4 off
CALL Send(0, 8, "SENSe:FUNCtion 'XTIMe:VOLTage3'", 1)       ' Channel 3 also on

CALL Send(0, 8, "TRACe:COPY M2_1,CH1", 1)
' The result is that the acquisition traces of the channels 1 and 3 are copied to M2_1 respectively M2_3.

CALL Send(0, 8, "TRACe:COPY M3_1,M2_1", 1)
' The result is that the previously stored traces in M2_1 and M2_3 are copied to M3_1 respectively m3_3.
```

3.10.3 Writing data to trace memory

The **TRACe** command allows you to write data from the controller into a memory register. The following possibilities are available:

- Write a previously read trace using the TRACe? query.

  Example:
  Send → **TRACe? CH3** 'Queries for CH3 trace
  Read ← **<trace block>** 'Reads trace data block
  Send → **TRACe M2_3,<trace block>** 'Writes data block to M2_3
  The result is that trace area M2_3 is filled with the acquisition trace of channel 3.

  Programming note:
  The fixed command part (TRACe M2_3,) and the variable <trace block> must be sent separately. So, no EOI (End Or Identify) detection in between. Also the <trace block> must be sent without EOI detection and detection of the EOL (End Of Line) code, because the <trace block> could contain the EOL character, e.g., code 10 for CR.

- Write a trace of identical constants (range = -32767 ... 32767).

  Example:
  Send → **TRACe M2_4,1028** '1028 = 1024 + 4 = 0404 hex.
  This command fills all memory register M2_4 locations with the constant 0404 hexadecimal for 16-bit samples, and with 04 hexadecimal for 8-bit samples.

  Note: A trace can only be written to memory register space (Mi_n) and not to acquisition space (CHn).

PROGRAM EXAMPLE:

```
DIM response AS STRING * 2000             ' Dimensions trace buffer
CALL Send(0, 8, "TRACe? CH1", 1)          ' Requests for channel 1 trace
CALL Receive(0, 8, response$, 256)        ' Reads the channel 1 trace
length = IBCNT%                           ' IBCNT = number of data bytes

CALL Send(0, 8, "TRACe M2_3,", 0)         ' Sends fixed command part without EOI
CALL Send(0, 8, LEFT$(response$,length), 0)
                                          ' Sends variable <trace block> without EOI
CALL Send(0, 8, "", 1)                    ' Sends dummy string with EOI detection
```

3.10.4 Reading data from trace memory

The TRACe? query allows you to read the contents from one of the following trace memory registers:

- An acquisition trace from one of the input channels (CH1 to CH4).
- Previously stored trace data from one of the memory registers (M1 to M8 or to M50). This can be either an acquisition trace or a trace of constant values (refer to section 3.10.3).
- The result of a post processing function; CALCulate1 in M1 and CALCulate2 in M2 (refer to section 3.9 "Post processing").

PROGRAM EXAMPLE:

```
'*****
'Read the actual channel 1 trace into trace1$ and the filtered
'channel 1 trace into trace2$.
'*****
DIM trace1 AS STRING * 2000                  ' Dimensions trace buffer 1
DIM trace2 AS STRING * 2000                  ' Dimensions trace buffer 2
CALL Send(0, 8, "TRACe? CH1", 1)             ' Requests for channel 1 trace
CALL Receive(0, 8, trace1$, 256)             ' Reads channel 1 trace into trace1$

CALL Send(0, 8, "CALCulate:FEED 'CH1'", 1)   ' Input source = CH1
CALL Send(0, 8, "CALCulate:FILTer:FREQuency:STATe ON", 1)
' Enables frequency filtering; the filtered channel 1 trace is stored in M1_1.

CALL Send(0, 8, "TRACe? M1_1", 1)            ' Requests for M1_1 trace
CALL Receive(0, 8, trace2$, 256)             ' Reads M1_1 trace into trace2$
```

3.11 Screen/Display Functions

3.11.1 Brightness control

The DISPlay:BRIGhtness command allows you to control the brightness of the trace(s) displayed on the screen of your CombiScope instrument on a scale from 0.0 (low) to 1.0 (high). After a *RST command, the brightness intensity is 0.18.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "DISPlay:BRIGhtness .3", 1)    ' Sets brightness at 0.3.
```

3.11.2 Display functions

The DISPlay:WINDow and DISPlay:MENU commands allow you to use the following display functions:

- The WINDow1 functions use the front panel screen display of MEAS1/MEAS2, CURSORS, and MATH-FFT to read measurement data from the CombiScope instrument (refer to section 3.11.2.1).
- The WINDow2 function to write user-defined text on the screen (refer to section 3.11.2.2).
- The MENU function to display softkey menus on the screen (refer to section 3.11.2.3).

The layout of the display areas on the screen is as follows:

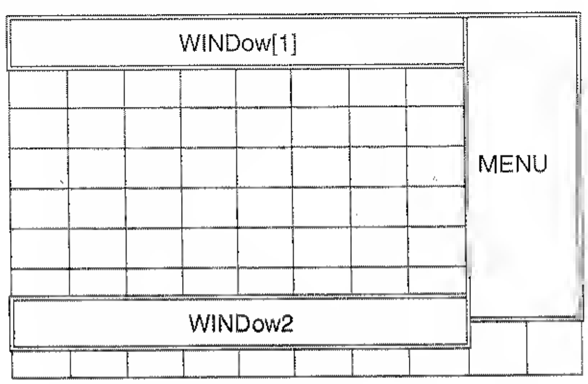


Figure 3.21 Screen layout of display functions

3.11.2.1 Readout of measurement data

The DISPlay:WINDow[1]:TEXT<n>:DATA? query allows you to acquire measured data as displayed on the upper line(s) of the screen of your CombiScope instrument. The following measured data values can be selected by specifying the number <n> in the query:

NUMBER <n>:	MEASUREMENT VALUE:
1, 2	MEAS1, MEAS2 data
10, 11, 12, 13, 20, 21, 30, 40, 51, 52	CURSORS data
60, 61	MATH - FFT frequency, amplitude

MEAS1/MEAS2 DATA:
The MEAS1 and MEAS2 functions must be enabled and selected via front panel control. MEAS1 data is read by sending the DISPlay:WINDow:TEXT1:DATA? query and MEAS2 data by sending the DISPlay:WINDow:TEXT2:DATA? query, followed by reading the response strings.

The format of a response string is as follows:

<meas_type>,<meas_value>,<suffix_unit>

DESCRIPTION:	<meas_type>	<suffix_unit>:
DC voltage	dc	V
AC-RMS voltage	rms	V
minimum voltage	min	V
maximum voltage	max	V
peak-to-peak voltage	pkpk	V
low level voltage	low	V
high level voltage	high	V
overshoot percentage	over	%
preshoot percentage	pre	%
frequency	freq	Hz
period time	T	s
pulse width	puls	s
rise time	rise	s
fall time	fall	s
duty cycle percentage	duty	%
delay time between 2 channels	del	s

Example:

Send → *RST	'Switches MEAS1 & 2 off
Send → DISPlay:MENU MEASure	'Switches MEASURE menu on
Send → SYSTem:KEY 2;KEY 4	'Switches MEAS1 and MEAS2 on
Send → DISPlay:WINDow:TEXT1:DATA?	'Requests MEAS1 data
Read ← pkpk,6000E-04,V	'Response = peak-to-peak 0.6 volt.

CURSORS DATA:
The CURSORS function offers a wide variety of voltage and time readouts. The following readout selections can be made via the CURSORS - READOUT softkey menu:

<n>:	TYPE:	UNIT:	DESCRIPTION:
10	dV	V	Voltage difference (delta-V) between the cursors.
	dY	U	Vertical voltage (X-deflection on).
11	V1	V	Absolute voltage of cursor 1 to ground.
12	V2	V	Absolute voltage of cursor 2 to ground.
13	Vdc	V	DC voltage
20	dT	s	Time difference (delta-T) between the cursors.
21	F	Hz	Frequency (1/dT) in Hertz.
30	dX	U	Horizontal voltage (X-deflection on).
40	phase	*	The phase between two channels in degrees Celsius. (* stands for degrees ° sign)
51	T1-trg	s	The time between cursor 1 and the trigger event.
52	T2-trg	s	The time between cursor 2 and the trigger event.

MATH - FFT DATA:
The MATH1/MATH2 - FFT functions offer the readout of the relative or absolute frequency and amplitude. The following readout selections can be made via the CURSORS - READOUT and MATH - FFT - PARAM softkey menus:

<n>:	TYPE:	UNIT:	DESCRIPTION:
60	FFT-freq	Hz	FFT frequency in Hertz.
61	FFT-ampl	variable	FFT amplitude in: - Relative FFT selected: dB - Absolute FFT selected: dBm, dbμV, V (Vrms)

PROGRAM EXAMPLE:

Read and print the DC and frequency characteristic of the actual signal using the MEAS1 and MEAS2 functions. The program stops to let you make the requested MEAS selections.

```
DIM response AS STRING * 30
CALL Send(0, 8, "DISPlay:MENU MEASure", 1)      ' Displays MEASURE menu
'
'***** Enable MEAS1 & MEAS2 and select MEAS1-DC and MEAS2-frequency.
'
PRINT ">>> Press the LOCAL key, set MEAS1 function on, and select
                                                        MEAS1-volt-dc."
PRINT ">>> Set MEAS2 function on and select MEAS2-time-freq."
PRINT ">>> Press any key on the controller keyboard when finished."
WHILE INKEY$ = "": WEND

CALL Send(0, 8, "DISPlay:WINDow:TEXT1:DATA?", 1)   ' Queries for volt-dc
CALL Receive(0, 8, response$, 256)                ' Reads volt-dc value
PRINT "Measured volt-dc = "; LEFT$(response$, IBCNT% - 1)

CALL Send(0, 8, "DISPlay:WINDow:TEXT2:DATA?", 1)   ' Queries for time-freq
CALL Receive(0, 8, response$, 256)                ' Reads time-freq value
PRINT "Measured time-freq = "; LEFT$(response$, IBCNT% - 1)
```

3.11.2.2 Display of user-defined text

The DISPlay:WINDow2:TEXT commands allow you to define and clear the user text on the screen area of your CombiScope instrument. After a *RST command, the display of the previously defined user text is turned off.

PROGRAM EXAMPLE 1: (text as string data)

```
CALL Send(0, 8, "DISPlay:WINDow2:TEXT:STATe ON", 1)    ' Enables display of text
CALL Send(0, 8, "DISPlay:WINDow2:TEXT:DATA 'Remote control'", 1)
'
' Displays the text: Remote control on the screen of your CombiScope instrument.
```

PROGRAM EXAMPLE 2: (text as block data)

```
CALL Send(0, 8, "DISPlay:WINDow2:TEXT:CLEar", 1)              ' Clears the text
CALL Send(0, 8, "DISPlay:WINDow2:TEXT:DATA #01.25 k", 0)    ' Displays: 1.25 k
CALL Send(0, 8, CHR$(25), 0)                                  ' Displays: Ω
CALL Send(0, 8, " CH1", 1)                                    ' Displays: CH1
'
' Displays the text: 1.25 kW CH1 on the screen of your CombiScope instrument.
```

Note: *The ASCII character 25 (= ↓) is displayed as Ω on the screen of your CombiScope instrument.*

3.11.2.3 Selection of softkey menus

The DISPlay:MENU commands allow you to select and enable the display of a softkey menu. If a menu is selected via the DISPlay:MENU command, the display is automatically enabled. After a *RST command, the display of softkey menus is turned off.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "DISPlay:MENU CURSors", 1)         ' Selects and displays the
                                                    CURSORS menu.
CALL Send(0, 8, "DISPlay:MENU:STATe OFF", 1)       ' Switches the CURSORS menu
                                                    display off.
```

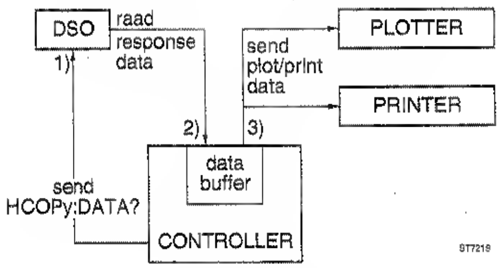
3.12 Print/Plot Functions

The HCOPy:DEVice <TYPE> command allows you to select a hardcopy device. The following selections can be made:

DEVICE:	TYPE:	NOTE:
Plotter	HPGL	HPGL plot data format
Plotter	HP7440	
Plotter	HP7550	
Plotter	HP7475A	
Plotter	HP7470A	
Plotter	PM8277	
Plotter	PM8278	
Printer	FX80	Epson FX80 compatibles (9 points)
Printer	HP2225	ThinkJet
Printer	LO1500	Epson LO150 compatibles (24 points)
Printer	HPLASER	HP LaserJet series II & III
Generator	DUMP_M1	Trace dump to one of the arbitrary waveform generators PM5138, PM5139, or PM5150.

The HCOPy:DATA? query allows you to request a hardcopy of the picture on the screen of your CombiScope instrument. The response data is formatted according to the current printer/plotter options, which can be selected via the front panel UTILITY menu. After a *RST command, the option "plotter; HPGL" is selected.

The response data to a HCOPy:DATA? query can be sent to a connected plotter or printer to make a hardcopy. The response data is sent as block data of indefinite length and is therefore, preceded by the preamble #0 of 2 bytes. This preamble must be removed from the beginning of the block data, before sending it to a plotter or printer device.



1) Send the query HCOPy:DATA? via the GPIB.
2) Read the block response data via the GPIB.
3) Send tha print/plot data part to the printer/plotter.

Figure 3.22 Hardcopy of screen on printer/plotter

PROGRAM EXAMPLE:

Select one of the supported GPIB plotters, set its address at 22 and connect the plotter via IEEE to the controller. Create a screen picture on the DSO that you want to plot and run the following program.

```
DIM addr(2)                                  ' Dimensions address array.
DIM response AS STRING * 15000               ' Dimensions response string.
CALL IBTMO(0, 13)                            ' Timeout at 10 seconds.

CALL Send(0, 8, "HCOPy:DEVice PM8277", 1)    ' Selects the PM8277 plotter
CALL Send(0, 8, "HCOPY:DATA?", 1)            ' Requests for hardcopy data.
CALL Receive(0, 8, response$, 256)           ' Reads the hardcopy data.
length = IBCNT%                              ' IBCNT = number of read bytes
PRINT "Number of hardcopy bytes ="; length
'*****
' The first 2 characters of the response block data are #0 (preamble for indefinite length).
' They must not be sent to the plotter; so, send characters 3 until 3+length-2.
'*****
CALL Send(0, 22, MID$(response$, 3, length - 2), 0)   ' No End detection
CALL Send(0, 22, "", 1)                                ' End of data block
```

3.13 Real-Time Clock

The real-time clock keeps track of the current date and time. The date and time are stamped on acquired waveforms to be sent to a computer or to be output to a hardcopy device. The time of stamping is also the time of the acquisition trigger.

The SYSTem:TIME command sets the time in hours, minutes, and seconds. Only a 24-hours time format is supported. The format of the displayed time cannot be selected.

The SYSTem:DATE command sets the date in years, months, and days.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "SYSTem:TIME 14,25,36", 1)      Sets the time to 25 minutes and 36
                                                 seconds past 2 o'clock in the
                                                 afternoon.
CALL Send(0, 8, "SYSTem:DATE 1993,12,15", 1)    Sets the date to 15 december 1993.
```

3.14 Auto Calibration

Calibration is only possible when the CombiScope instrument is warmed up. The instrument data is calibrated automatically by sending the *CAL? or the CALibration? query. The internal calibration lasts several minutes. A "0" result is returned after correct calibration, and a "1" result is returned when the calibration failed. Notice that the response to the calibration query is only returned when the calibration has completed.

During the calibration process bit 0 "Calibrating" is set in the operation status condition register. This bit cannot be read during the execution of the *CAL? or CALibration? query, because these queries are sequential commands. This bit can be read after sending the CALibration command, which is an overlapped command. The completion of the CALibration command is reported in the standard Event Status Register (ESR) bit 0 (OPC bit set to 1). When the calibration is finished, bit 8 in the OUEStionable status reports a possible calibration error (if set to 1).

Note: *Execute calibration only when it is needed, e.g., when a message on the screen of your CombiScope instrument requests to do so.*

PROGRAM EXAMPLE:

```
'*****
'Calibrate the instrument and print the calibration result.
'*****
CALL Send (0, 8, "*CAL?", 1)              ' Starts the calibration
CALL IbTMO(0, 0)                          ' Disables the time out mechanism
response$ = " "
CALL Receive (0, 8, response$, 256)
' Waits for the calibration to finish and reads the result.
'
CALL IbTMO(0, 13)                         ' Sets time out back to 10 seconds
IF LEFT$(response$, 1) = "0" THEN         ' 0 = okay
  PRINT "Calibration okay"
ELSE                                      ' 1 = wrong
  PRINT "Calibration not successful"
ENDIF
```

PROGRAMMING NOTE:

Status bit 0 in the operation status can be used to generate a Service Request (SRQ) when the calibration is finished, i.e., when bit 0 becomes zero. This gives you the advantage that the program can do something else until the SRO is generated. Therefore, program the following:

```
ON PEN GOSUB ServReq                      ' Defines "ServReq" routine call after SRQ
PEN ON                                    ' Enables SRQ mechanism

Send → STATus:OPERation:NTRansition 1
'Sets bit 0 (Calibration) true in the case of negative transition (from 1 to 0).

Send → STATus:OPERation:ENABle 1
'Enables bit 0 for being reported in the standard status byte (STB).

Send → *SRE 128
'Enables bit 7 (OPER) in Service Request Enable (SRE) register for generation of an SRQ.

Send → *RST                               ' Resets the instrument
Send → *CLS                               ' Clears the status data
Send → CALibration                        ' Starts auto calibration
```

3.15 Status Reporting

Status reporting is done via the status reporting system, which is completely described in chepter 5 "THE STATUS REPORTING SYSTEM" of the SCPI Users Handbook. The following figure shows the principle of the standerd Status Byte (STB) register and the Service Request Generation (SRQ) mechanism:

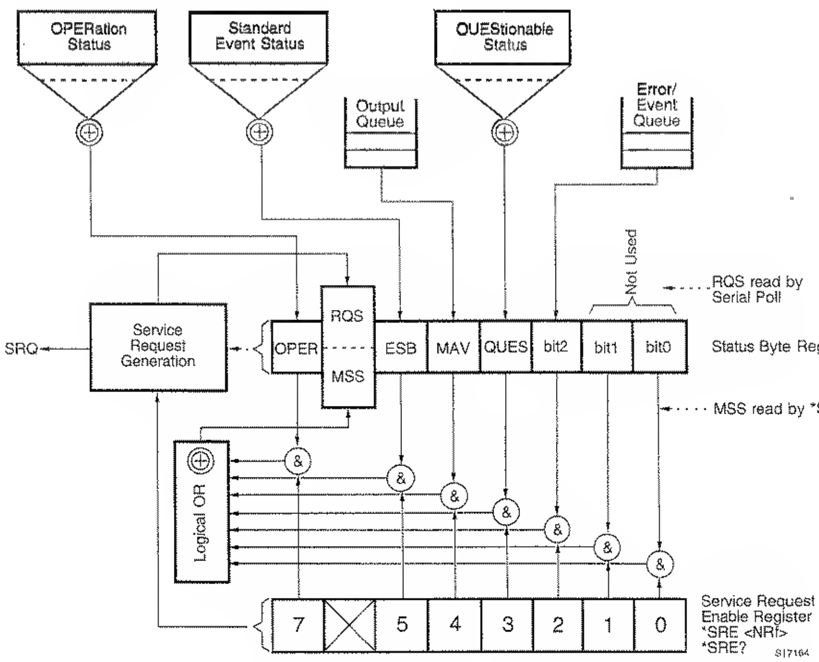


Figure 3.23 The status reporting model for CombiScope instruments

3.15.1 Status data for the CombiScope instruments

The following status data applies to the CombiScope instruments:

- For the meaning of the bits of the OPERetion stetus, refer to section 3.15.1.1.
- For the meaning of the bits of the QUEStionable status, refer to section 3.15.1.2.
- For the meening of the bits of the standerd Event Status Register, refer to the command reference for the *ESR? query.
- The message output queue can contain ebout 250 dete bytes.
- The error/event queue can contain 20 error messages before it overflows.

3.15.1.1 *Operation status data*

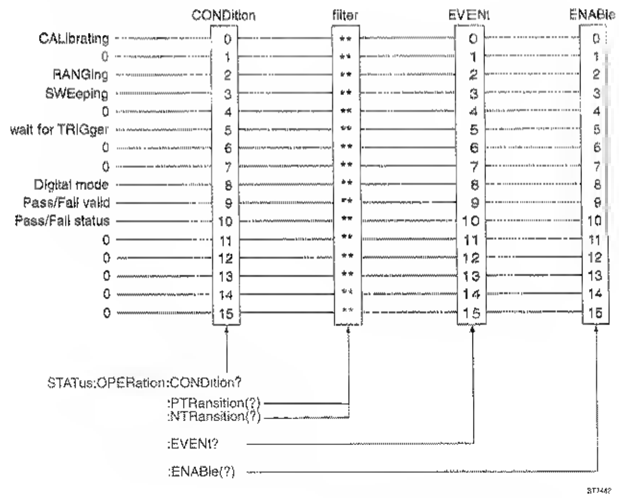


Figure 3.24 The Operation Status structure

BIT:	MEANING:
0	*CALibrating* This bit is set during the time that the instrument is performing a calibration.
2	*RANGing* This bit is set during the time that the instrument is autoranging (autosetting).
3	*SWEeping* This bit is set when the sweep (a data acquisition) is in progress. This bit is reset to zero when the data acquisition is finished. At the same time, the OPC bit (0) in the standard Event Status Register (ESR) is set. Only valid for multiple-shot mode (INITiate:CONTinuous OFF).
5	*Waiting for TRIGger* This bit is set when the trigger system is initiated (INITiate) and waiting for a trigger to start an acquisition. This bit is reset to zero as soon as the instrument is triggered and the acquisition started. Only valid for single-shot and multiple-shot mode (INITiate:CONTinuous OFF).
8	*Digital mode* This bit is set when the CombiScope instrument is in the digital moda.
9	*Pass/Fail valid* This bit is set when the pass/fail status at bit 10 is valid.
10	*Pass/Fail status* This bit is sat if tha pass/fail test has failad. If bit 9 = 1 and bit 10 = 0, the test has passed. If bit 9 = 1 and bit 10 = 1, the test has failed.

Table 3.3 The Operation Status bits

3.15.1.2 Questionable status data

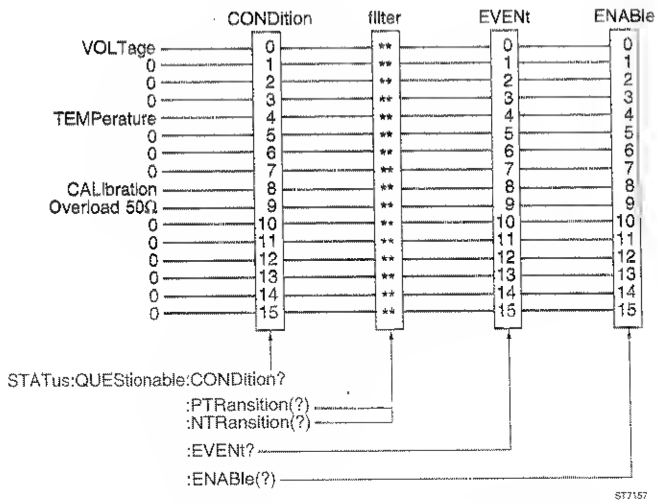


Figure 3.25 The Questionable Status structure

BIT:	MEANING:
0	*VOLTage* This bit is set if a digital sample value is clipped at the maximum or minimum value while a FETCh? query is done on the sample array. This bit is also set if a FETCh? query did not succeed because the shape of the waveform did not match the measure function request. Example: FETCh:FREQuency? in the case of only half a sine wave.
4	*TEMPerature* This bit is set by the instrument if the difference between the current temperature and the temperature at the moment of the last calibration exceeds a certain level. This is an indication that the instrument must be calibrated. The temperature is sensed internally about half an hour after power on. This bit is reset after power on and after calibrating.
8	*CALibration* This bit is set by the instrument when an internal calibration did not complete successfully. This bit is reset after power on and after successful calibration.
9	*Overload 50Ω* This bit is set by the instrument when any 50Ω input terminator is overloaded. This bit is reset after power on, or if none of the input terminators is overloaded.

Table 3.4 The Questionable Status bits

3.15.2 How to reset the status data

The *CLS command allows you to clear the following status data structures:

- All event status registers, such as the following:
  - standard event status register (ESR)
  - status byte register (STB)
  - operation event status register (STATus:OPERation:EVENt)
  - questionable event status register (STATus:QUEStionable:EVENt)
- The Error/event queue.

The STATus:PRESet command presets the filters and enable register of the operation and questionable status data in such a way that device-dependent events are reported. The result is as follows:

STATUS REGISTER	DATA STRUCTURE	PRESET VALUE
OPERation	ENABle register	0000 hex.
	PTRansition filter	7FFF hex.
	NTRansition filter	0000 hex.
OUEStionable	ENABle register	0000 hex.
	PTRansition filter	7FFF hex.
	NTRansition filter	0000 hex.

Note: *A *RST command does not affect the contents of:*
- event registers
- event enable registers
- output queues
- transition filters

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*CLS", 1)               ' Clears the event registers + error/event queue
CALL Send(0, 8, "STATus:PRESet", 1)      ' Presets the enable register + filters
```

3.15.3 How to enable status reporting

The principle of using the status reporting mechanism is explained by showing two program examples. In the first example the standard Status Byte (STB) is checked to signal "operation completed". In the second example the SRQ mechanism is used to signal "operation completed" by generating a Service Request.

3.15.3.1 Program example using the status byte (STB)

PROGRAM EXAMPLE:

In this example the standard status byte (STB) is checked to detect whether or not a "CONFigure:AC" + "INITiate" operation is completed. If completed, the program continues by fetching and printing the AC-RMS value.

```
CALL IBTMO(0, 13)                       ' Timeout at 10 seconds
CALL Send(0, 8, "*RST", 1)              ' Resets the instrument
CALL Send(0, 8, "*ESE 1", 1)            ' Enables OPC-bit (0) in ESE
' "OPeration Completed" is reported in bit 5 (ESB) of the STB after sending *OPC.
'
CALL Send(0, 8, "CONFigure:AC", 1)      ' Automatic configuration
CALL Send(0, 8, "*OPC", 1)
' This command forces the instrument to set the OPC bit
' when all pending operations have been finished.
'
CALL Send(0, 8, "INITiate", 1)          ' Single initiation
ESB.bit.set = 0
result$ = SPACE$(3)
WHILE ESB.bit.set = 0
  CALL Send(0, 8, "*STB?", 1)           ' Requests for the STB
  CALL Receive(0, 8, result$, 256)      ' Reads the STB
  IF (VAL(result$) AND 32) THEN         ' ESB = bit 5 (value 32)
    ESB.bit.set = 1                     ' Operation completed
  END IF
WEND
CALL Send(0, 8, "FETCh:AC?", 1)         ' Fetches AC-RMS value
result$ = SPACE$(30)
CALL Receive(0, 8, result$, 256)        ' Reads AC-RMS value
PRINT "AC-RMS value = "; result$        ' Prints AC-RMS value
```

3.15.3.2 Program example using a service request (SRQ)

PROGRAM EXAMPLE:

In this example the "Service Request" mechanism is used to detect whether or not a "CONFigure:AC" + "INITiate" operation is completed. If completed, an SRQ is generated to continue with fetching and printing the AC-RMS value.

```
SRQ.detected = 0
ON PEN GOSUB ServReq                        ' Defines SRQ-routine
PEN ON                                      ' Enables SRQ-routine
CALL IBTMO(0, 13)                           ' Timeout at 10 seconds
CALL Send(0, 8, "*RST", 1)                  ' Resets the instrument
CALL Send(0, 8, "*ESE 1", 1)                ' Sets OPC-bit in ESR
' "OPeration Completed" is reported in bit 5 (ESB) of STB after sending *OPC.
'
CALL Send(0, 8, "*SRE 32", 1)               ' Sets ESB-bit in SRE-register
' SRQ generation after "OPeration Completed" is enabled.
'
CALL Send(0, 8, "CONFigure:AC", 1)          ' Automatic configuration
CALL Send(0, 8, "INITiate", 1)              ' Single initiation
CALL Send(0, 8, "*OPC", 1)
' This command forces the instrument to set the OPC bit in the STB
' when all pending operations have been finished.
'
WHILE SRQ.detected = 0
' Do something else while waiting for SRQ; continue when SRQ.detected = 1.
WEND
CALL Send(0, 8, "FETCh:AC?", 1)             ' Fetches AC-RMS value
result$ = SPACE$(30)
CALL Receive(0, 8, result$, 256)            ' Reads AC-RMS value
PRINT "AC-RMS value = "; result$            ' Prints AC-RMS value
END
'
ServReq:
  PRINT "Service request generated because of Operation Completed."
  CALL ReadStatusByte(0, 8, sbyte%)
  ' Serial polls for the status byte to reset the SRQ-mechanism.
  '
  PRINT "STB byte ="; sbyte%
  CALL Send(0, 8, "*ESR?", 1)
  ' Queries for the contents of the Event Status Register to clear the OPC-bit.
  '
  resp$ = " "
  CALL Receive(0, 8, resp$, 256)
  PRINT "ESR byte = "; resp$
  SRQ.detected = 1
RETURN
```

3.15.4 How to report errors

Instrument errors usually caused by programming or setting errors, can be reported by the instrument during the execution of each command. To make sure that a progrem is running properly, you should query the instrument for possible errors after every functional command. This is done by sending the SYSTem:ERRor? query or the STATus:QUEue? query to the instrument, followed by reading the response messege. However, through this practice the seme "error reporting" stetements must be repeated after sending each SCPI command. This is not always practical. Therefore, one of the following approaches is advised:

1) Send the SYSTem:ERRor? or STATus:QUEue? query and read the instrument response message after every group of commands that functionally belong to each other.
2) Program an error-reporting routine and call this routine after each command or group of commands. For an example of an error-reporting routine, refer to section 3.16.4.1.
3) Program an error-reporting routine and use the "Service Request (SRQ) Generation" mechanism to interrupt the execution of the program and to execute the error-reporting routine. Therefore, refer to section 3.16.4.2.

3.15.4.1 Error-reporting routine

Send the SYSTem:ERRor? or STATus:QUEue? query and read the instrument response after every group of commands that functionally belong to each other, by calling an error-reporting routine after each group of commands.

PROGRAM EXAMPLE:

```
DIM response AS STRING * 30
CALL Send (0, 8, "CONFigure:AC (@1)", 1)     ' Configures for AC-RMS
FOR i = 1 TO 20                              ' Performs 20 measurements
  CALL Send (0, 8, "READ:AC?", 1)
  CALL Receive (0, 8, response$, 256)        ' Reads the AC-RMS value
  PRINT "AC-RMS: "; response$                ' Prints the AC-RMS value
  GOSUB ErrorCheck                           ' Checks for instrument errors
NEXT i
'*****
'***** REST OF THE APPLICATION
'*****
END
ErrorCheck:
  CALL Send (0, 8, "SYSTem:ERRor?", 1)       ' Queries for a system error
  CALL Receive (0, 8, response$, 256)        ' Reads the instrument error
  PRINT "Error: "; response$                 ' Prints the instrument error
RETURN
```

3.15.4.2 Error-reporting using the SRQ mechanism

Program an error-reporting routine and use the "Service Request (SRQ) Generation" mechanism to interrupt the execution of the program to execute the error-reporting routine.

PROGRAM EXAMPLE:

```
ON PEN GOSUB ErrorCheck
PEN ON
'*****
'***** APPLICATION PROGRAM
'*****
END
' *************************************************
' Subroutine reading all errors from the error queue.
' *************************************************
SUB ErrorCheck
  er$ = SPACE$(1)
  WHILE LEFT$(er$, 1) <> "0"          ' Loop until 0, 'No error"
    CMD$ = "SYSTem:ERRor?"
    CALL Send(0, 8, CMD$, 1)          ' Sends error query
    er$ = SPACE$(60)
    CALL Receive(0, 8, er$, 256)      ' Reads error string
    PRINT "Error = "; er$             ' Displays error string
  WEND
END SUB
```

3.16 Saving/Restoring Instrument Setups

This level of programming involves all functions in the CombiScopes instruments, i.e., complete instrument setups are processed. This allows you to program one or more functions that are not individually programmable. The following possibilities can be programmed:

- Restoring initial settings.
- Saving/restoring complete setups via internal memory.
- Saving/restoring complete or partical setups via the GPIB controller.

3.16.1 How to restore initial settings

Initial settings can be restored by sending the *RST command. This resets the instrument-specific functions to a default state and selects the digital mode.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)
' Resets the instrument (for reset values, refer to the *RST command in the command reference).
```

3.16.2 How to save/restore a setup via instrument memory

Complete instrument setups can be stored and recalled via one of the internal memories of the CombiScope instrument. The settings in recall memory 0 are the initial settings. The settings in the recall memories 1 through 10 are user programmable.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*SAV 3", 1)      ' Saves the complete instrument setup into memory 3.
CALL Send(0, 8, "*RCL 3", 1)      ' Recalls the complete instrument setup from memory 3.
```

3.16.3 How to save/restore a setup via the GPIB controller

Complete instrument setups or a part of the setup (node) can be stored and recalled via the external memory of the controller using the SYSTem:SET? <node> query (store setup) and SYSTem:SET command (recall setup).

PROGRAM EXAMPLE:

```
DIM settings AS STRING * 350               ' Reserves space for instrument settings
CALL Send(0, 8, "SYSTem:SET?", 1)          ' Queries for the complete instrument setup
                                           ' '(no <node> parameter specified)
CALL Receive(0, 8, settings$, 256)         ' Reads the instrument settings
length = IBCNT%                            ' IBCNT% = number of settings bytes
CALL Send(0, 8, "SYSTem:SET ", 0)          ' Sends the command header (note the space)
                                           ' EOI checking disabled (0)
CALL Send(0, 8, LEFT$(settings$, length), 1)   ' Sends the instrument settings
                                               ' EOI checking enabled (1)
```

3.17 Front Panel Simulation

The use of "front panel simulation" commands must be restricted to special applications or front panel functions that are not supported by SCPI commands. Bear in mind the differences between different instruments from the same family, as described in the beginning of this chapter.

It is possible to simulate the pressing of a key on the front panel by using the SYSTem:KEY command. It is also possible to detect whether or not a key has been pressed. This is done via bit 6 (URQ) of the Event Status Register (*ESR? query). The last key pressed can be queried by using the SYSTem:KEY? query.

Furthermore, it is better to use the DISPlay:MENU command to switch a softkey menu ON or OFF. The pressing of a softkey can be simulated with the SYSTem:KEY 1 to 6 command. Since the role of each softkey is determined by a previously selected menu, this will be a tedious and cumbersome process. Still it might be of interest for simple applications.

Example:
The command sequence *RST;DISPlay:MENU ACQuire;:SYSTem:KEY 2 resets the instrument (e.g., digital mode on and peak detection off), switches the softkey menu ACQUIRE on, and simulates the pressing of softkey 2, which causes peak detection to be switched on.

3.17.1 How to simulate the pressing of a front panel key

The SYSTem:KEY commands allow you to simulate the pressing of a front panel key. The front panel key numbering (not the rotary knobs) is roughly divided into the following matrix of rows and columns.

column:	1	2	3	13
row 1	101	102	103	113
row 2	201	202	203	213
row 3	1	302	303	313
row 4	2	402	304	413
	.	.	.	.
	.	.	.	.
row 7	6	702	703	713
row 8	801	802	803	813

Note: The number positions 1 to 6 represent the softkeys.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                   ' Resets the instrument
CALL Send(0, 8, "SYSTem:KEY 104", 1)         ' Enables the UTILITY softkey menu
CALL Send(0, 8, "SYSTem:KEY 2", 1)           ' Selects the PROBE option
CALL Send(0, 8, "SYSTem:KEY 5", 1)           ' Selects the PROBE CORR option
CALL Send(0, 8, "SYSTem:KEY 4", 1)           ' Selects the 10:1 option
CALL Send(0, 8, "SYSTem:KEY 104", 1)         ' Disables the UTILITY softkey menu
' In this example the probe correction factor for input channel 1 is set at 10:1  via softkey menu UTILITY.
```

AUTOSET SIMULATION:

```
CALL Send (0, 8, "SYSTem:KEY 101", 1)   ' Simulates Autoset
```

Autoset scans for the presence of a signal on channel 1, 2, and the external trigger input. If there is a signal present on the external trigger input, the EXTernal trigger channel is selected as trigger source, and the external trigger view facility becomes active.
If the external trigger is the only signal available, external trigger view and channel 1 (CH1) are switched on.

3.17.2 How to simulate the operation of a softkey menu

The MEASure:MENU command allows you to enable or disable the display of the softkey menus. The "SYSTem:KEY 1 to 6" command allows you to simulate the pressing of one of the softkeys 1 to 6.

PROGRAM EXAMPLE:

```
CALL Send(0, 8, "*RST", 1)                      ' Resets the instrument
CALL Send(0, 8, "DISPlay:MENU UTIL", 1)         ' Enables the UTILITY softkey menu
CALL Send(0, 8, "SYSTem:KEY 2;KEY 5;KEY 4", 1)
' Selects the PROBE + PROBE CORR + 10:1 options.
CALL Send(0, 8, "DISPlay:MENU:STATe OFF", 1)    ' Disables the UTILITY softkey menu
' In this example the probe correction factor for input channel 1 is set at 10:1 via softkey menu UTILITY.
```

3.18 Functions not Directly Programmable

Not all front panel functions are individually programmable with SCPI commands. However, the SYSTem:SET and *SAV/*RCL commands can be used to access the following functions:

- Cursor functions	see CURSORS menu (appendix B.2.2)
- Logic Triggering	see TRIGGER menu (appendix B.2.10)
- Event functions	see TB MODE menu (appendix B.2.9)
- DTB functions	see DTB (DEL'D TB) menu (appendix B.2.6)
- X pos	see X POS button
- Display menu functions	see DISPLAY menu (appendix B.2.3)
- Pass/Fail functions	see MATHPLUS MATH menu (appendix A5 and B.2.4.)

Other functions and keys that are not individually programmable with SCPI commands are accessible using the SYSTem:KEY command. They are:

- Roll mode	DISPlay:MENU TBMode;:SYSTem:KEY 3 toggles on/off
- Trigger noise	DISPlay:MENU TRIGger;:SYSTem:KEY 4 toggles on/off
- TEXT OFF key	SYSTem:KEY 801 selects next option
- STATUS key	SYSTem:KEY 201 toggles on/off
- MAGNIFY keys	SYSTem:KEY 210/211 selects previous/next step
- ENVELOPE	DISPlay:MENU ACQuire;:SYSTem:KEY 3 toggles on/off
- MULTiple-shot	DISPlay:MENU TBMode;:SYSTem:KEY 1 (up)or 2 (down) (after INITiate:CONTinuous OFF)

4 COMMAND REFERENCE

In the first section the notation conventions concerning the specification of the syntax end deta types are given.

In the second section a summary of all commands and associate paremeters is given in alphabeticel order. This gives you a quick reference of the SCPI commands.

In the third section detailed descriptions of all commands and queries for the CombiScopes instruments instruments are given. The IEEE.2 commands/queries (beginning with a *) are listed first, followed by the SCPI commands and queries in alphabetical order.

4.1 Notation Conventions

4.1.1 Syntax specification notations

The method that is used in this manual to specify the syntax of the commands is based on the EBNF notations. To be able to correctly spell the commands, you need to be familiar with the concept of this notation. The notation form uses 3 types of symbols that need to be distinguished:

Meta symbols

Meta symbols have a particular meaning. They don't specify any literal or message element, but serve a particular purpose.

Example: | is the symbol for alternative. 0 | 1 means either 0 or 1.

Non-terminal symbols

Non-terminal symbols are message elements that are specified elsewhere. They are placed between the < > signs.

Example: <Boolean> means a boolean value.

Terminal symbols

Terminal symbols consist of e sequence of litereis that use the standerd ASCII character set. Any ASCII symbol that is not e mete symbol or a non-terminal symbol is considered to be a literel.

Notes:

(1) A message that is specified as a sequency of literals can be sent to the instrument in any upper or lower case combination. The case of the characters has no semantical meaning.

(2) Upper and lower case characters in a syntax specification are used to distinguish between the short and long form of a mnemonic. Upper case specifies the mandatory short form of a mnemonic. The lower case characters specify the remaining part of the (optional) long form.

(3) Literals that are non-printable ASCII characters are underlined. For example, the symbol NL is used to specify the New Line character (0A $_{\text{hexadecimal}}$).

(4) Some syntax specifications use the control symbol ^. The characters that follow this symbol specify a special message that is concurrently sent with the preceding data byte. For example, NL^End specifies that the NL code is sent concurrently with the End message (via the EOI line of the GPIB interface).

<table>
<tr><th>META SYMBOL:</th><th>MEANING:</th><th>EXPLANATION:</th></tr>
<tr><td>=</td><td>Is defined to be</td><td>Specifies equality.
Example: <manufacturer> = FLUKE</td></tr>
<tr><td>|</td><td>Alternative</td><td>Specifies an "either" "or" choice.
Example: <result> = 0 | 1</td></tr>
<tr><td>< ... ></td><td>Non-terminal symbol</td><td>A non-terminal is a message element whose syntax specification is defined elsewhere. Example:
A node can be specified as INPut<n>. The definition of <n> = [1] | 2 is specified at another line or even somewhere else.</td></tr>
<tr><td>[...]</td><td>Default</td><td>This means that the syntax may or may not contain the message element in between the square brackets, without changing the semantical meaning.
Example:
MEASure[:VOLTage][:DC]? means that MEASure:VOLTage:DC? is the same as MEASure? or MEASure:VOLTage? or MEASure:DC?</td></tr>
<tr><td>{ ... }</td><td>Repetition</td><td>Specifies that the message element in between the curly brackets may be repeated 0 or more times. Example:
<parameter> {,<parameter>} specifies a comma separated sequence of one or more <parameter>'s.</td></tr>
</table>

Notes:

(1) A space character that needs to be part of a message is specified as SP. Speces within a syntax specification that are not specified as SP are used for formatting purposes to improve the reedability; they don't have any semantical meening.

Note: *The only exception to this rule is the progrem header separator, which separates the header from the parameter part in e message. For reasons of readability, this required syntacticel element is not specified in eny syntax definition. Sending e SP in between the header end parameter part will satisfy this requirement.*

Example: The syntax specification INPut:STATe ON requires a SP character in between the STATe node and the ON parameter. This message is sent as INPut:STATeSPON. Sending INPut:STATeON causes a Command Error.

(2) Except for the program header separator, any message from the Command Summary and Command Specification sections can be sent to the instrument exactly as defined by the syntax specification. However, these specifications do not reflect all details of the flexible syntax structure that is allowed when creating composite messages.

(3) The characters > and < in a string expression are considered as meta symbols. When these characters are to be sent as literals in a string, they are placed between quote characters.

Example: The specification "CH<n>", where <n> = [1] | 2, specifies the following strings: "CH" | "CH1" | "CH2" , but "Number ">" 2" specifies the string characters Number > 2.

4.1.2 Data types

<NRf> = <NR1> | <NR2> | <NR3>
Decimal Numeric Data.

<NR1> = <sign> <digit> {<digit>}
Notation for specifying a decimal number, e.g., -179.
<sign> = [+] | -

<NR2> = <NR2> is the same format es <NR1>, except that it uses an explicit decimal point and may or may not be preceded by a sign, e.g., -179.56.

<NR3> = <NR3> is the same format es <NR2>, except that an exponent is edded, e.g., -1.7956 E + 02.

<integer> = <digit> {<digit>}
Integer notation that specifies a number.

<numeric_data> = <NRf> | <hexadecimal_data> | <octal_data> | <binery_date>
Any decimal or non-decimal numeric deta type.

<hexadecimel_data> = #H <hex_digit> {<hex_digit>}
<hex_digit> is one of the characters 0 .. 9 or A .. F.

<octal_data> = #Q <octal_digit> {<octal_digit>}
<octal_digit> is one of the digits 0 .. 7.

<binary_data> = #B <binary_digit> { <binary_digit> }
<binary_digit> = 0 | 1

<Boolean> = 0 | 1 | OFF | ON
0 equals OFF; 1 equals ON.

<block_data> = <definite_block> | <indefinite_block>
This is used to transfer data that consists of any arbitrary 8 bit codes.

<indefinite_block> = #0 {<dab>}
This data type is of indefinite length and must be terminated by NL^END.

<dab> = Any arbitrary 8 bit data byte code.

<definite_block> = # <digit> <length> {<dab>}
This data type is of definite length.
<digit> specifies the number of bytes of <length>.
<length> specifies the number of <dab> bytes.

<digit> = One of the ASCII characters 0 .. 9.

<character_data> = <alpha_character> { <alpha_character> | _ | <digit> }
<alpha_character> is eny elphabetic ASCII cheracter.

<string_date> = Sequence of ASCII characters placed between single or double quotes.
Exemples: "This is a string"
'This also'

<channel_list> = (@ <NRf>)
Example: (@2)

4.2 Command Summary

The following list is a summary of all commands and parameters in alphabetical order, beginning with the common commands. The corresponding queries of the commands are not listed. If a command has no query, this is reported in the column NOTES as "no query". If only a query exists, it is reported in the column NOTES as "query only".

COMMAND:	PARAMETERS:	NOTES:
*CAL?		query only response = 0 | 1
*CLS		no query
*ESE	<numeric_data>	range = 0 .. 255
*ESR?		query only
*IDN?		query only
*OPC		response to *OPC? is always 1
*OPT?		query only
*RCL	<numeric_data>	range = 0 .. 10
*RST		no query
*SAV	<numeric_data>	range = 1 .. 10
*SRE	<numeric_data>	range = 0 .. 255
*STB?		query only
*TRG		no query
*TST?		query only
*WAI		no query

<table>
<tr><th>COMMAND:</th><th>PARAMETERS:</th><th>NOTES:</th></tr>
<tr><td>ABORt</td><td></td><td>no quary</td></tr>
<tr><td>CALCulate<n></td><td></td><td><n> =[1] | 2</td></tr>
<tr><td>:DERivative</td><td></td><td>alias = :DIFFerential</td></tr>
<tr><td>:POINTs</td><td><numeric_data> | MAX | MIN</td><td>range = 3, 5, .., 129</td></tr>
<tr><td>:STATa</td><td><Boolean></td><td></td></tr>
<tr><td>:FEED</td><td>"<trace_name>"</td><td><trace_name> = CHn | Mi_n
n = 1 .. 4
i = 1 .. 8 (standard memory)
i = 9 .. 50 (extended memory)</td></tr>
<tr><td>:FILTer</td><td></td><td></td></tr>
<tr><td>[:GATE]</td><td></td><td></td></tr>
<tr><td>:FREQuency</td><td></td><td></td></tr>
<tr><td>:POINts</td><td><numeric_data> | MAX | MIN</td><td>range = 3, 5, .., 41</td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>:INTegral</td><td></td><td></td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>:MATH</td><td></td><td></td></tr>
<tr><td>[:EXPRession]</td><td>(<trace_name> <operation>
<trace_name>)</td><td><trace_name> = CHn | Mi_n
<operation> = + | - | *</td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>:TRANsform</td><td></td><td></td></tr>
<tr><td>:FREQuency</td><td></td><td></td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>:TYPE</td><td>ABSolute | RELative</td><td></td></tr>
<tr><td>:WINDow</td><td>RECTangular | HAMMing | HANNing</td><td></td></tr>
<tr><td>:HISTogram</td><td></td><td></td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>CALibration</td><td></td><td></td></tr>
<tr><td>[:ALL]</td><td></td><td>response = 0 | 1</td></tr>
<tr><td>CONFigure</td><td></td><td>see Note 1, 2, and 3</td></tr>
<tr><td>[:VOLTage]</td><td></td><td></td></tr>
<tr><td><measura_function></td><td>[[(<voltage_parameters>),]
<measure_parametars>]
[,<channel_list>]</td><td></td></tr>
</table>

<table>
<tr><th>COMMAND:</th><th>PARAMETERS:</th><th>NOTES:</th></tr>
<tr><td>DISPlay</td><td></td><td></td></tr>
<tr><td>:BRIGhtness</td><td><NRf> | MAXimum | MINimum</td><td><NRf> = 0.00 .. 1.00</td></tr>
<tr><td>:MENU</td><td></td><td></td></tr>
<tr><td>[:NAME]</td><td>TBMode | TRIGger | DMODe | SETups | CURSors | ACQuire | DISPlay | MATH | MEASure | SAVE | RECall | UTIL | VERTical</td><td></td></tr>
<tr><td>:STATE</td><td><Boolean></td><td></td></tr>
<tr><td>:WINDow[1]</td><td></td><td></td></tr>
<tr><td>:TEXT<n></td><td></td><td><n> = 1 | 2 | 10 | 11 | 12 | 13 | 20 | 21 | 30 | 40 | 51 | 52 | 60 | 61</td></tr>
<tr><td>:DATA?</td><td></td><td>query only</td></tr>
<tr><td>:WINDow2</td><td></td><td></td></tr>
<tr><td>:TEXT[1]</td><td></td><td></td></tr>
<tr><td>:CLEAR</td><td></td><td>no query</td></tr>
<tr><td>:DATA</td><td><string_data> | <block_data></td><td></td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>FETCh</td><td></td><td>see Note 1, 2, 3, and 4</td></tr>
<tr><td>[:VOLTage]</td><td></td><td>response = <NR3></td></tr>
<tr><td><measure_function>?</td><td>[[(<voltage_parameters>),] <measure_parameters>] [,<channel_list>|<trace_list>]</td><td></td></tr>
<tr><td>FORMat</td><td></td><td></td></tr>
<tr><td>[:DATA]</td><td><type> [,<length>]</td><td>INTeger,8 (for 8-bit samples)
INTeger,16 (for 16-bit samples)</td></tr>
<tr><td>HCOPy</td><td></td><td></td></tr>
<tr><td>:DATA?</td><td></td><td>query only
response = <indefinite_block></td></tr>
<tr><td>:DEVice</td><td>HPGL | HP7440 | HP7550 | HP7475A| HP7470A | PM8277 | PM8278 | FX80 | LO1500 | HP2225 | HPLASER | DUMP_M1</td><td></td></tr>
<tr><td>INITiate</td><td></td><td></td></tr>
<tr><td>[:IMMediate]</td><td></td><td>no query</td></tr>
<tr><td>:CONTinuous</td><td><Boolean></td><td></td></tr>
</table>

COMMAND:	PARAMETERS:	NOTES:
INPut<n>		<n> = [1] | 2 | 3 | 4
:COUPling	AC | DC | GROund	
:FILTer		
[:LPASs]		
[:STATe]	<Boolean>	
:FREQuency?		query only response = 2E+7
:IMPedance	<NRf> | MAXimum | MINimum	<NRf> = 50 | 1E6
:POLarity	NORMal | INVerted	<n> = 2 | 4
INSTrument		
:NSELect	<NRf> | MAXimum | MINimum	<NRf> = 1 | 2
[:SELect]	DIGital | ANALog	
MEASure		see Note 1, 2, and 3
[:VOLTage]		response = <NR3>
<measure_function>?	[[(<voltage_parameters>),] <measure_parameters>] [,<channel_list>]	
READ		see Note 1, 2, and 3
[:VOLTage]		response = <NR3>
<measure_function>?	[[(<voltage_parameters>),] <measure_parameters>] [,<channel_list>]	

<table>
<tr><th>COMMAND:</th><th>PARAMETERS:</th><th>NOTES:</th></tr>
<tr><td>SENSe</td><td></td><td></td></tr>
<tr><td>:AVERage</td><td></td><td></td></tr>
<tr><td>[:STATe]</td><td><Boolean></td><td></td></tr>
<tr><td>:COUNt</td><td><NRf> | MAXimum | MINimum</td><td><NRf> = 2, 4, .., 4096</td></tr>
<tr><td>:TYPE?</td><td></td><td>response = SCAL</td></tr>
<tr><td>:FUNCtion</td><td></td><td></td></tr>
<tr><td>[:ON]</td><td>"XTIMe:VOLTage<...>"</td><td>no query</td></tr>
<tr><td>:OFF</td><td>"XTIMe:VOLTage<...>"</td><td>no query</td></tr>
<tr><td>:STATe?</td><td>"XTIMe:VOLTage<...>"</td><td>query only
<...> = [1] | 2 | 3 | 4
<...> = :SUM 1,2
<...> = :SUM 3,4</td></tr>
<tr><td>:SWEep</td><td></td><td></td></tr>
<tr><td>:OFFSet</td><td></td><td></td></tr>
<tr><td>:TIME</td><td><NRf> | MAXimum | MINimum</td><td>+ = post-trigger delay time
- = pre-trigger view time</td></tr>
<tr><td>:PDETection</td><td><Boolean></td><td></td></tr>
<tr><td>:REALtime</td><td></td><td></td></tr>
<tr><td>[:STATe]</td><td><Boolean></td><td></td></tr>
<tr><td>:TIMe</td><td><NRf> | MAXimum | MINimum</td><td>over 10 divisions</td></tr>
<tr><td>:AUTO</td><td><Boolean></td><td></td></tr>
<tr><td>:VOLTage<n></td><td></td><td><n> = [1] | 2 | 3 | 4</td></tr>
<tr><td>[:DC]</td><td></td><td></td></tr>
<tr><td>:RANGe</td><td></td><td></td></tr>
<tr><td>:AUTO</td><td><Boolean></td><td></td></tr>
<tr><td>:OFFSet</td><td><NRf> | MAXimum | MINimum</td><td></td></tr>
<tr><td>:PTPeak</td><td><NRf> | MAXimum | MINimum</td><td>over 8 divisions</td></tr>
<tr><td>STATus</td><td></td><td></td></tr>
<tr><td>:OPERation</td><td></td><td></td></tr>
<tr><td>[:EVENt]?</td><td></td><td>query only</td></tr>
<tr><td>:CONDition?</td><td></td><td>query only</td></tr>
<tr><td>:ENABle</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:NTRansition</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:PTRansition</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:PRESet</td><td></td><td>no query</td></tr>
<tr><td>:QUEStionable</td><td></td><td></td></tr>
<tr><td>[:EVENt]?</td><td></td><td>query only</td></tr>
<tr><td>:CONDition?</td><td></td><td>query only</td></tr>
<tr><td>:ENABle</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:NTRansition</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:PTRansition</td><td><numeric_data></td><td>range = 0 .. 32767</td></tr>
<tr><td>:QUEue</td><td></td><td></td></tr>
<tr><td>[:NEXT]?</td><td></td><td>query only</td></tr>
</table>

<table>
<tr><th>COMMAND:</th><th>PARAMETERS:</th><th>NOTES:</th></tr>
<tr><td>SYSTem</td><td></td><td></td></tr>
<tr><td>:BEEPer</td><td></td><td></td></tr>
<tr><td>:STATe</td><td><Boolean></td><td></td></tr>
<tr><td>:COMMunicate</td><td></td><td></td></tr>
<tr><td>:SERial</td><td></td><td></td></tr>
<tr><td>:CONTrol</td><td></td><td></td></tr>
<tr><td>:DTR</td><td>ON | STANdard</td><td></td></tr>
<tr><td>:RTS</td><td>ON | STANdard</td><td></td></tr>
<tr><td>[:RECeive] | TRANsmit</td><td></td><td></td></tr>
<tr><td>:BAUD</td><td><numeric_value></td><td>75 | 110 | 150 | 300 | 600 | 1200 |
2400 | 4800 | 9600 | 19200 |
38400</td></tr>
<tr><td>:BITS</td><td><numeric_value></td><td>7 | 8</td></tr>
<tr><td>:PACE</td><td>XON | NONE</td><td></td></tr>
<tr><td>:PARity</td><td></td><td></td></tr>
<tr><td>[:TYPe]</td><td>EVEN | ODD | NONE</td><td></td></tr>
<tr><td>:DATE</td><td><NRf>,<NRf>,<NRf></td><td><year>,<month>,<day></td></tr>
<tr><td>:ERRor?</td><td></td><td>query only</td></tr>
<tr><td>:KEY</td><td><NRf> | MAXimum | MINimum</td><td><NRf> = 1 .. 6
101 .. 113
| .. |
801 .. 813</td></tr>
<tr><td>:SET</td><td><indefinite_block></td><td></td></tr>
<tr><td>:SET?</td><td><node_number></td><td>response = <indefinite_block></td></tr>
<tr><td>:TIME</td><td><NRf>,<NRf>,<NRf></td><td><hour>,<minute>,<second></td></tr>
<tr><td>:VERSion?</td><td></td><td>query only</td></tr>
<tr><td>TRACe</td><td></td><td>alias = DATA</td></tr>
<tr><td>:COPY</td><td><destination_trace>,
<source_trace></td><td><destination_trace> = Mi_n
<source_trace> =
CHn | Mi_n | EXT
n = 1 .. 4, E
i = 1 .. 8 (standard)
i = 1 .. 50 (extended)</td></tr>
<tr><td>[:DATA]</td><td><destination_trace>,<definite_block></td><td></td></tr>
<tr><td>:POINts</td><td><source_trace>
[,<NRf> | MAXimum | MINimum]</td><td><NRf> (standard) =
512 | 2048 | 4096 | 8192
<NRf> (extended) =
512 | 8192 | 16384 | 32768</td></tr>
</table>

COMMAND:	PARAMETERS:	NOTES:
TRIGger		
[:SEQuence[1] | STARt]		
:FILTer		
:HPASs		
:FREQuency	3E4	30 KHz = HF-reject
:STATe	<Boolean>	
:LPASs		
:FREQuency	0 | 10 | 3E4	0 = DC coupling 10 = AC coupling 30000 = LF-reject
:STATe	<Boolean>	
:HOLDoff	<NRf> | MINimum | MAXimum	
:LEVel	<NRf> | MAXimum | MINimum	
:AUTO	<Boolean>	
:SLOPe	POSitive | NEGative | EITHer	
:SOURce	IMMediate | INTernal<n> | LINE | BUS | EXTernal	<n> = [1] | 2 | 3 | 4
:TYPE	EDGE | VIDeo | LOGic | GLITch	
:VIDeo		
:FIELd		
[:NUMBer]	1 | 2	1/2 = field1/field2
:SELect	ALL | NUMBer	ALL = lines triggering NUMBer = field triggering
:FORMat		
[:TYPE]	PAL | SECAM | NTSC | HDTV	video standard
:LPFRame	525 | 625 | 1050 | 1125 | 1250	number of lines per frame
:LINE	<NRf> | MINimum | MAXimum	from 1 to 1250
:SSIGnal	POSitive | NEGative	signal polarity

Note 1:

<voltage_parameters> = [<expected_voltage> [,<resolution>]]

Note 2:

<measure_function>	<measure_parameters>
:AC	
:AMPLitude	
[:DC]	
:FALL	
:OVERshoot	
:PREShoot	
:TIME	[<reference_low> [,<reference_high>[,<expected_time> [,<time_resolution>]]]
:FREQuency	[<expected_frequency> [,<frequency_resolution>]]
:HIGH	
:LOW	
:MAXimum	
:MINimum	
:NDUTycycle	[<reference_middle>]
:NWIDth	[<reference_middle>]
:PDUTycycle	[<reference_middle>]
:PERiod	[<expected_period> [,<period_resolution>]]
:PTPeak	
:PWIDth	[<reference_middle>]
:TMAXimum	
:TMINimum	
:RISE	
:OVERshoot	
:PREShoot	
:TIME	[<reference_low> [,<reference_high> [,<expected_time> [,<time_resolution>]]]

:DCYCle = alias for :PDUTycycle
:FTIMe = alias for :FALL:TIME
:RTIMe = alias for :RISE:TIME

Note 3:

<channel_list> = @1 | @2 | @3 | @4

Note 4:

<trace_list> = @CH1 | @CH2 | @CH3 | @CH4
@Mi_1 | @Mi_2 | @Mi_3 | @Mi_4
i = 1 .. 8 (standard memory)
i = 1 .. 50 (extended memory)

4.3 Command Descriptions

The description of corresponding commands and queries is combined. Each command/query description starts on a new page. A description consists of the following parts:

COMMAND HEADER

Syntax:
Specifies the syntax of a command or query (header + parameters) to be placed on the GPIB. Different programming languages (such as BASIC, C, Pascal) have different ways of representing data that is to be output onto the GPIB. It is up to the programmer to determine the methods to output the command required for the programming language used.

Alias:
Specifies alternative syntax possibilities.

Query form:
Specifies the syntax of the corresponding query (optional).

Response:
Specifies the response of the instrument to a query (optional).

Description:
Describes what the command/query does.

limitations:
Specifies possible limitations with respect to using and operation.

Example:
Program examples are included with each command description. ONLY THE COMMAND STRING IS GIVEN. No other programming details are shown, because the method used to send the command string differs, depending upon the GPIB drivers and programming language used. Notation used:

Send → <command_string> Example: `Send → *OPT?`	This means: send the query *OPT? to the instrument.
Read ← <response_string> Example: `Read ← IEEE:0:0,MP:0:0`	This means: read the response IEEE:0:0,MP:0:0 from the instrument.

Errors:

Specifies possible error numbers plus their meaning. The error number, plus the corresponding text can be requested by sending the SYSTem:ERROR? or STATus:QUEue? query.

Front panel compliance:

Specifies the compliance with front panel operations.

PROGRAMMING NOTES:

- It is advised to send the commands *RST and *CLS first, before executing the programming examples in this chapter. In this way the oscilloscope is reset to default settings (*RST) and the status data cleared (*CLS).
- Be aware of coupled commands during command execution. Coupling information is described in the command descriptions. Coupling means that an instrument may change other functions or values, which are not directly programmed by sending this command.
  Example: The vertical sensitivity is derived from the programmed peak-to-peak value (SENSe:VOLTage:RANGe:PTPeak). The programmed trigger level (TRIGger:LEVel) is adapted to the vertical sensitivity to keep the signal display on the screen.
- In the remote state the front panel keys will have no effect on programmed settings. Local front panel control can be obtained by pressing the LOCAL key, provided the instrument is not programmed Locally Locked Out (LLO). After power on the oscilloscope is in its local state, i.e., controlled via the front panel.
- All commands and queries are sequential commands, except the INITiate, INITiate:CONTinuous, and CALibration command (overlapped commands).

Note; *Overlapped commands are commands that can be executed in overlap with other commands. Sequential commands are commands that are completed first, before a next command is executed.*

*CAL? CALibration

Syntax: *CAL?

Response: 0 | 1

0 Calibration okay.

1 Calibration not okay.

Description:

This query performs an automatic internal self-calibration and reports the result of that calibration. No external means or operator interface is needed. The response indicates whether or not the instrument completed the self-calibration without error. A response of 0 indicates that the calibration executed successfully. A response of 1 indicates that the calibration was not successful.
A possible calibration error is also reported via bit 8 in the QUEStionable status. If bit 8 = 0, the calibration was successful. If bit 8 = 1, the calibration went wrong. The *CAL? query is the equivalent of the CALibration[:ALL]? query.

Limitation:

The calibration process will last a couple of minutes. During this time bit 0 in the OPERation status is set, indicating that calibration is busy. This status information can only be requested, if the calibration was started via the front panel. This is because the *CAL? query is a sequential command. So, a next command or query in the same program message is not executed until the calibration process is completed. Until then, no response to a next query is obtained.

Example:

```
Send → *CAL?
Read ← <response>            Response is held up during calibration.
IF <response> = 1 THEN PRINT "calibration not successful."
```

Front panel compliance:

The *CAL? query is the remote equivalent of the front panel CAL key.

*CLS Clear Status

Syntax: *CLS

Description:

The *CLS command clears the following status data structures:

1. Clears all Event Status Registers, such as the following:
   - Standard Event Status Register (*ESR?)
   - Status Byte Register (*STB?)
   - Operation Event Status register (STATus:OPERation:EVENt)
   - Ouestionable Event Status Register (STATus:QUEStionable:EVENt)
2. Clears the Error/Event Queue.
3. Cancels the effect of the *OPC command and the *OPC? query; any request for the OPC flag is cancelled.

Note: *When the *CLS command is entered as the first command in a new program message, it also clears the Output Queue and as a consequence, the MAV-bit in the Status Byte Register.*

Example:

`Send → *CLS` Clears the status data.

*ESE Event Status Enable

Syntax: *ESE <numeric_data>

Query form: *ESE?

Response: <integer>

Description:

The command sets and the query reports the contents of the standard Event Status Enable register (ESE). The range of the 8-bit ESE contents is between 0 and 255 decimal. The contents of the standard Event Status Enable (ESE) register determine which bits in the standard Event Status Register (ESR) are enabled to be summarized in the Status byte Register (STB). The contents of the standard ESE register are cleared at Power on.

Example:

`Send → *ESE 17`	Enables the EXE (Execution Error) and the OPC (Operation Complete) bits to be summarized in the Status Byte Register. Alternative commands *ESE #B10001 and *ESE #H11.
`Send → *ESE?`	
`Read ← 17`	The bits 4 (= EXE bit) and 0 (=OPC bit) are set.

*ESR? Event Status Register

Syntax: *ESR?

Response: <integer>

Description:

The *ESR? query reports the contents of the standard Event Status Register (ESR) and clears it. The range of the 8-bit ESR contents is between 0 and 255 decimal.

PON	URO	CME	EXE	DDE	QYE	RQC	OPC	
7	6	5	4	3	2	1	0	ESR

The meaning of the bits is as follows:

- bit 7: PON = Power ON
- bit 6: URQ = User Request
- bit 5: CME = Command Error
- bit 4: EXE = Execution Error
- bit 3: DDE = Device Dependent Error
- bit 2: QYE = Ouery Error
- bit 1: RQC = Request Control
- bit 0: OPC = Operation Complete

Notes:

- PON indicates that the power supply has been turned off and on since the last time the register was read or cleared. Bit 7 (PON) is always set true at power on.
- URO indicates that the user has requested attention, e.g., to return the instrument to local.
- Bit 1 (ROC) is not used (always 0).
- QPC indicates that the device has completed all previously started actions.

Example:

```
Send → *ESR?
Read ← 28
```

28 is equal to the binary value #B11100 (16 + 8 + 4 decimal),which means that the bits 4 (EXE), 3 (DDE), and 2 (QYE) are set. So, an execution error, a device-dependent error and a query error have occurred since the last time the register was read.

*IDN? Identification

Syntax: *IDN?

Response: <manufacturer>,<model>,<serial_number>,<sw_level>

<manufacturer>	E.g., FLUKE
<model>	E.g., PM3392A
<serial_number>	Always 0
<sw_level>	<sw_id>:<mask_id>:<UFO_id>
<sw_id>	Firmware identification, consisting of: - Software type, e.g., SW3394AIM (I=IEEE, M=Math Plus) - Software version, e.g., V1.0 - Software date (year-month-day)
<mask_id>	Mask identification, e.g., UHM V1.0
<UFO_id>	UFO identification, e.g., UFO V2.0

Description:

The *IDN? query reports the identification of the instrument. The response to the *IDN? query consists of the fields above in Arbitrary ASCII Response Data format. This implies that the *IDN? query must be the last query in a program message unit, because the arbitrary ASCII response data is terminated with the New Line character (10 decimal).
The <sw_id> parameter identifies the type, version, and date of the instrument firmware.
The <mask_id> parameter identifies the version of the Universal Host Mask processor software.
The <UFO_id> parameter identifies the version of the Universal Front processor software.

Example:

```
Send → *IDN?
Read ← FLUKE,PM3384A,0,SW3394AIM V2.0 1994-09-15:UHM V1.0:UFO V2.0
```

Front panel compliance:

The *IDN? query is the remote equivalent of the Maintenance option of the UTILITY menu.

*OPC Operation Complete

Syntax: *OPC

Query form: *OPC?

Response: 1

Description:

The *OPC command causes the instrument to set the operation complete bit (OPC) in the standard Event Status Register (ESR), when all pending operations have been finished. When the *OPC command is received, the OPC bit is set in the *ESR register when all pending operations have been completed. The OPC bit is cleared, along with the other bits in the *ESR register, when the *ESR? query is executed.

PON	URQ	CME	EXE	DDE	QYE	RQC	OPC	
7	6	5	4	3	2	1	0	ESR

The *OPC? query places the ASCII character 1 in the output queue when all pending operations are finished. So, when the *OPC query is received, the instrument holds off the GPIB handshake as long as it is addressed as talker and there are device operations pending. Operations exist, as for example INITiate:CONTinuous ON, that never complete. Sending *OPC? during this operation prevents the instrument from responding to further program messages.

*Note: The *RST command, the *CLS command, and power on cancel the effect of an *OPC command or an *OPC? query.*

Restrictions:

Be careful. The GPIB controller may interrupt the program by means of timeout. So, verify first whether the timeout period is long enough to cover the operation time of the instrument.

Example:

`Send → *RST; *CLS`	Resets instrument clears status data.
`Send → INITiate:CONTinuous ON`	Continuous initiation.
`Send → *OPC; *ESR?`	
`Read ← 0`	Indicates that the instrument is busy sweeping.
`Send → INITiate:CONTinuous OFF`	No initiation any more.
`Send → *OPC; *ESR?`	
`Read ← 1`	Indicates that the instrument has finished sweeping.

*OPT? Option identification

Syntax: *OPT?

Response: <option> {,<option>}

<option>	<name>:<serial_nr>:<sw_level>
<name>	IEEE I EXT I EM I MP
<serial_nr>	Serial number is always 0.
<sw_level>	Software level is always 0.

Description:

The *OPT? query reports which options are present.
If <option> = IEEE:0:0, the IEEE-488.2/SCPI option is installed.
If <option> = EXT:0:0, the EXTernal trigger option is installed.
If <option> = EM:0:0, Extended Memory is available.
If <option> = MP:0:0, the Math Plus option is installed.

Example:

`Send → *OPT?`	
`Read ← IEEE:0:0,MP:0:0`	The IEEE and MathPlus option are available.

Front panel compliance:

The *OPT? query is the remote equivalent of the Maintenance option of the UTILITY menu.

*RCL Recall instrument setup

Syntax: *RCL <numeric_data>

Description:

The *RCL command restores instrument settings from one of the internal memory registers 0 .. 10. The settings in memory register 0 are standard settings, which can only be recalled. The settings in the memory registers 1 through 10 are programmable by sending the *SAV command.
After power on the current settings, just before power off, are restored. These current settings are saved in non-volatile memory (battery backed-up).

Example:

`Send → *SAV 2`	Stores the actual instrument settings into memory register 2.
.	
.	
`Send → *RCL 2`	Restores the instrument settings from memory register 2.

Front panel compliance:

The *SAV/*RCL commands are the remote equivalent of the front panel softkey operation via the SETUPS/RECALL menu. The standard settings stored in memory 0 can be changed via the front panel FRONT SETUPS menu.

*RST Reset

Syntax: *RST

Description:

The *RST command resets the instrument. The hardware and software of the instrument is initialized without affecting any of the IEEE interface conditions. The instrument turns into a fixed setup, which is optimized for remote operation. This fixed setup is different from the setup that can be recalled via the front panel softkeys and the SETUPS menu, which is optimized for local control.

The *RST command affects the following:

- Sets the following instrument settings, independent of the past history:

FUNCTION:	DEFAULT SETTING(S):
Digital mode	ON
X-deflection (X vs Y)	OFF
Delayed Time Base	OFF
Main Time Base	Sweep time 10 ms (total acquisition)
	Autoranging OFF
X-magnify factor	x1
Channel 1 ON	200 mV/div
	DC coupled
	Position centred
	Impedance 1 MΩ (without probe)
Channels 2, 3 and 4	OFF
	Polarity NORMal (INV OFF)
	add1+2 (CH1+CH2) OFF
	add3+4 (CH3+CH4) OFF
Trigger	Type EDGE
	Source IMMediate
	Slope POSitive
	Level-pp OFF
	Noise ON
	Level MAXimum (1.64 V)
	DC signal coupling
	Video mode ALL (lines)
	Video signal polarity POSitive
	625 video lines per frame
	Video line/field = 1/1
	Hold-off time = 0
	Low-pass filter ON
	Low-pass cutoff frequency 0 Hz (DC coupling)
	High-pass filter OFF
	High-pass cutoff frequency bandwidth (100/200 MHz)
TB mode	Single shot
	Roll mode OFF

FUNCTION:	DEFAULT SETTING(S):
TB mode	Realtime only OFF Event delay OFF Acquisition length 512 (samples of 16 bits) Trigger Level MAX
Acquire	Averaging OFF Peak detection OFF Envelope OFF Autoranging attenuators OFF
Acquisition	Locked
Pre-trigger view	50% of MTB (-5 ms)
Bandwidth limiter	OFF
Measure 1 & 2	OFF
Math 1 & 2	OFF
Cursors	OFF
Trace intensity	0.18
User text	Data cleared
Display	OFF
Beeper	ON
Hardcopy PRINT & PLOT	Plotter; HPGL
Pass/Fail testing	OFF

- Cancels or aborts any instrument-dependent action.
- Cancels the effect of the *OPC command and the *OPC? query.
- Sets the TRIGger subsystem into its IDLE state.

The *RST command does not affect the following:

- State of the IEEE 488.1 interface.
- GPIB (IEEE 488.1) address of the instrument.
- Contents of the Output Queue.
- Contents of the Error/Event Queue.
- Service Request Enable setting in the SRE register.
- Transition filters in the status subsystem.
- Event registers in the status subsystem.
- Event enable registers in the status subsystem.
- Calibration data that affects the device specifications.
- Version number set by the SYSTem:VERSion command.
- Contents of the internal memory registers (*SAV/*RCL).

Example:

`Send → *RST`

Front panel compliance:

All settings not mentioned in the description are set according to the front panel fixed setup, which can be recalled by pressing the keys STATUS and TEXT OFF at the same time.

*SAV Save instrument setup

Syntax: *SAV <numeric_data>

Description:

The *SAV command saves the current instrument settings into one of the internal memory registers 1 .. 10. The settings in memory register 0 are standard settings, which can only be recalled. The settings in the memory registers 0 through 10 can be recalled by sending the *RCL command.

Example:

Send → *SAV 2	Stores the actual instrument settings into memory register 2.
.	
.	
Send → *RCL 2	Restores the instrument settings from memory register 2.

Front panel compliance:

The *SAV/*RCL commands are the remote equivalent of the front panel softkey operation via the SETUPS/RECALL menu. The standard settings stored in memory 0 can be changed via the front panel FRONT SETUPS menu.

*SRE Service Request Enable

Syntax: *SRE <numeric_data>

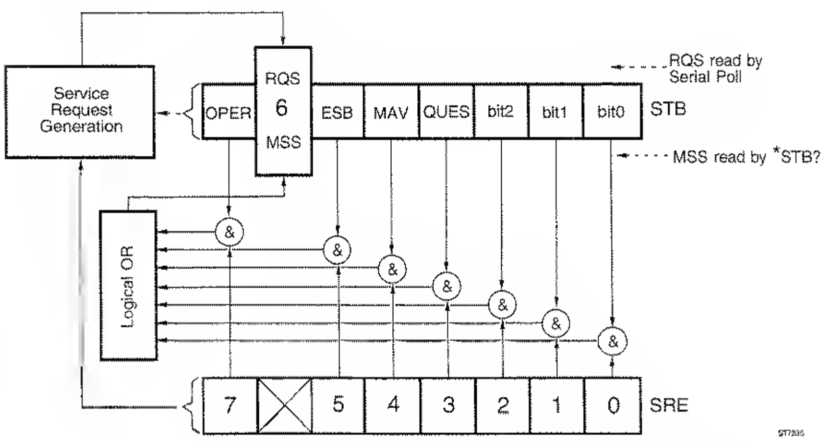
Query form: *SRE?

Response: <integer>

Description:

The command sets and the query reports the contents of the Service Request Enable (SRE) register. The range of the 8-bit ES R contents is between 0 and 255 decimal. However, bit 6 (value 64) is ignored, and will always be reported zero. Therefore, the real range is from 0 to 63 and from 128 to 191. The bits in the Service Request Enable Register (*SRE) determine the following:

- Which corresponding bits in the Status Byte register (STB) cause a service request from the instrument.
- Which corresponding bits in the Status Byte register (STB) are summarized in the MSS-bit in the *STB register.



A bit value of 1 indicates an enable condition and a bit value of 0 indicates a disable condition. To meke sure that the service request line is activated only when a new reason for service occurs, the status byte is not updated efter a SRQ (Service Request) has occurred until:

- A seriel poll is done.
- The reeson for service no longer exists, e.g., after reading the contents of the event register.

Exemple:

`Send → *SRE #B100000` This sets bit 5 ESB in the Service Request Enable Register.

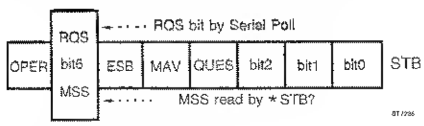
*STB? Status Byte

Syntax: *STB?

Response: <integer>

Description:

The *STB? query reports the contents of the Status Byte register (STB). The range of the 8-bit STB contents is between 0 and 255 decimal. The Status Byte Register contains the summary status of all overlaying status registers and queues.



Notes:

- OPER = OPERation status (bit 7)
  Contains the summary of the OPERation status register structure.
- RQS = Requested Service (bit 6)
  Indicates that the device requests for service, i.e., SRQ=1 in the GPIB interface. It differs from the MSS bit in that the RQS bit is cleared after a serial poll. It is set true again only, when a new event occurs that requires service.
- MSS = Master Summary Status (bit 6)
  Indicates that there is an event that causes the device to request service. The MSS bit is cleared when the event(s) in the overlaying status structure that caused the Service Request are cleared.
- ESB = Event Summary Bit (bit 5)
  Contains the summary of the Standard Event Status register structure.
- MAV = Message Available (bit 4)
  Indicates whether the Output Queue contains at least one message (bit = 1) or is empty (bit = 0).
- QUES = OUEStionable status (bit 3)
  Contains the summary of the QUEStionable status register structure.
- bit 2 = Error/Event queue bit
  Indicates whether the Error/Event queue contains at least one message (bit = 1) or is empty (bit = 0).
- bit 1 = Device Dependent Status bit (not used)
- bit 0 = Device Dependent Status bit (not used)

Example:

Send → `*STB?`

Read ← `4` 4 is equal to the binary value #B100. This means that bit 2 is set, indicating that there is an error message in the Error/event Queue.

*TRG Trigger

Syntax: *TRG

Description:

The *TRG command triggers the instrument by generating a Group Execute Trigger (**GET**) code.

Example:

`Send → *RST`	Resets the instrument.
`Send → TRIGger:SOURce BUS`	GPIB becomes trigger source.
`Send → INITiate`	Initiates the instrument once.
`Send → *TRG`	Triggers the instrument.
`Send → FETCh:FREQuency?`	Fetches the frequency.
`Read ← <frequency>`	

*TST? Self-test

Syntax: *TST?

Response: 0 | 1

0 Self-test okay.

1 Self-test not okay.

Description:

The *TST? query initiates a RAM/ROM test in the instrument and returns the result of the test. The result of the RAM/ROM test is 0, if the test is completed without detecting any error. If the result is 1, the self-test failed. Upon successful completion of *TST?, the instrument settings are restored to their values prior to. the execution of *TST?.

Example:

```
Send → *TST?
Read ← <result>
IF <result> = 1 THEN PRINT "Self-test failed; instrument must
be repaired."
```

*WAI Wait-to-continue

Syntax: *WAI

Description:

The *WAI command prevents the instrument to execute any further command until all previous commands and queries have been completed. The *WAI command is used to force sequential execution of commands by the instrument. On receipt of the *WAI command, the instrument executes all pending commands and queries before it executes the next command or query.

Restrictions:

Be careful. The GPIB controller may interrupt the program by means of timeout. So, verify first whether the timeout period is long enough to cover the operation time of the instrument.

Example:

`Send → *RST`	Resets the instrument.
`Send → INITiate`	First initiation of the trigger system.
`Send → *WAI`	
`Send → INITiate`	Second initiation of the trigger system.

Notice that the second initiation is only executed when the actions of the first initiation have been completed.

Note: *The *OPC? query can also be used to achieve sequential execution of the first and the second INITiation.*

ABORt

Syntax: ABORt

Description:

The ABORt command resets the trigger system and placas it in tha "IDLE" stata. Pending actions that were already started are finished immediately. The ABORt command is not finished until the pending actions have been terminated.

Note: *The commands *RST and ABORt have the same effect on the trigger functions, except that ABORt does not affect the state of the INITiate:CONTinuous command. So, when an ABORt command is sent while the INITiate:CONTinuous is ON, the trigger system will leave the IDLE state at once.*

Example:

`Send → ABORt`	Aborts the current acquisition.
`Send → CONFigure:AC`	Configures for AC-RMS value.
`Send → READ:AC?`	Initiates and reads the AC-RMS value.
`Read ← <the measured AC-RMS value>`	

CALCulate<n>:DERivative:POINts
CALCulate<n>:DERivative:STATe

Syntax: CALCulate<n>:DERivative:POINts <numeric_data> | MAXimum | MINimum

CALCulate<n>:DERivative:STATe <Boolean>

<n> [1] | 2

<numeric_data> 3, 5, 7, ..., 127, 129

Alias: An alias for :DERivative is :DIFFerential.

Query form: CALCulate<n>:DERivative:POINts? [MINimum | MAXimum]

Response: 3 | 5 | .. | 129

If MINimum was specified, 3 is returned.
If MAXimum was specified, 129 is returned.

Query form: CALCulate<n>:DERivative:STATe?

Response: 0 | 1

0 Differentiate function turned off.
1 Differentiate function turned on.

Description:

The CALC<n>:DER:POIN command specifies the width of the differentiate window. The width of the differentiate window can be an odd number of points, varying from 3 points to 129 points in increments of 2 points. The differentiate window can be turned on with the CALCulate:DERivative:STATe command.
The CALC<n>:DER:STAT command switches the differentiate function on or off. The result of the differentiate function is stored in M1_n for CALCulate1 and in M2_n for CALCulate2 dependent on the input source CHn or Mi_n (n = 1, 2, 3, 4).
After a *RST command, the differentiate window width is 5 points and the differentiate function is turned off.

Example:

Send → `CALCulate:DERivative:POINts 21`	The width becomes 21 points.
Send → `CALCulate:DERivative:STATe ON`	Switches the differentiate function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:FEED

Syntax: CALCulate<n>:FEED "<trace_name>"

Note: The parameter "<trace_name>" is <string_data>. Therefore, it may be specified between single quotes as well, i.e., '<trace_name>'.

<n>	[1] I 2
<trace_name>	A trace name which is a predefined <acquisition_trace> or <memory_trace>.
<acquisition_trace>	CH1 I CH2 I CH3 I CH4
<memory_trace>	Mi_1 I Mi_2 I Mi_3 I Mi_4 Note: - i = 1 .. 8 (standard memory) - i = 9 .. 50 (extended memory)

Query form: CALCulate<n>:FEED?

Response: "CHn" I "Mi_n"

Note: - n = 1 .. 4 (n=1 .. 2 for PM33x0A)
- i = 1 .. 8 (standard memory)
- i = 9 .. 50 (extended memory)

Description:

The CALCulate:FEED command controls the source for the calculate function. The trace specified by <trace_name> is selected as source for the calculate block. After a *RST command, CH1 becomes the source for the CALCulate1 and CALCulate2 functions.

Limitations:

- A channel must be ON before it can be selected.
- An empty trace may not be used as source in a CALCulate command.
- M1_i is not allowed as source for a CALCulate1 command.
- M2_i is not allowed as source for a CALCulate2 command.

Example:

Send → `CALCulate2:FEED "CH3"`	Channel 3 becomes the source for MATH2.
Send → `CALCulate:FEED 'M8_4'`	M8_4 becomes the source for MATH1.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:FILTer[:GATE]:FREQuency:POINts
CALCulate<n>:FILTer[:GATE]:FREQuency:STATe

Syntax: CALCulate<n>:FILTer[:GATE]:FREQuency:POINts <numeric_data> | MAXimum | MINimum
CALCulate<n>:FILTer[:GATE]:FREQuency:STATe <Boolean>

<n>	[1] | 2
<Numeric_data>	3, 5, 7, .. , 39, 41

Query form: CALCulate<n>:FILTer[:GATE]:FREOuency:POINts? [MINimum | MAXimum]

Response: 3 | 5 | .. | 41

If MINimum was specified, 3 is returned.
If MAXimum was specified, 41 is returned.

Query form: CALCulate<n>:FILTer[:GATE]:FREOuency:STATe?

Response: 0 | 1

0 Filter function turned off.
1 Filter function turned on.

Description:

The CALC<n>:FILT:FREO:POIN command specifies the width of the filter window, which can be an odd number of points, varying from 3 points to 41 points in increments of 2 points. The filter window can be turned on with the CALCulate:FILTer[:GATE]:FREQuency:STATe command.
The CALC<n>:FILT:FREQ:STAT command switches the calculate function FILTer on or off. The result of the filter function is stored in M1_n for CALCulate1 and in M2_n for CALCulate2 dependent on the input source CHn or Mi_n (n = 1, 2, 3, 4). After a *RST command, the filter window width is 19 points and the filter function is turned off.

Example:

Send → `CALCulate:FILTer:FREQuency:POINts 21`	The width becomes 21 points.
Send → `CALCulate:FILTer:FREQuency:STATe ON`	Switches the FILTer function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:INTegral:STATe

Syntax: CALCulate<n>:INTegral:STATe <Boolean>

<n> [1] | 2

Query form: CALCulate<n>:INTegral:STATe?

Response: 0 | 1

0 Integrate function turned off.

1 Integrate function turned on.

Description:

This command switches the integrate function on or off. The result of the integrate function is stored in M1_n for CALCulate1 and in M2_n for CALCulate2 dependent on the input source CHn or Mi_n (n = 1, 2, 3, 4).
After a *RST command, the integrate function is turned off.

Example:

`Send → CALCulate:INTegral:STATe ON` Switches the integrate function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:MATH[:EXPRession]

Syntax: CALCulate<n>:MATH[:EXPRession] (<trace_name> <operation> <trace_name>)

<n>	[1] | 2
<trace_name>	A trace name which is a predefined <acquisition_trace> or <memory_trace>.
<acquisition_trace>	CH1 | CH2 | CH3 | CH4
<memory_trace>	Mi_1 | Mi_2 | Mi_3 | Mi_4 Note: - i = 1 .. 8 (standard memory) - i = 9 .. 50 (extended memory)
<operation>	+ | - | *

Query form: CALCulate<n>:MATH[:EXPRession]?

Response: (<trace_name> <operation> <trace_name>)

Description:

This command specifies the mathematical expression for the MATH function. The operation in the command parameter selects the calculate function, which can be add (+), subtract (-), or multiply (*). Both the source traces in the command parameter may not be empty. This command does not switch the mathematics function on; this is done with the CALCulate:MATH:STATe command.

Note: The first trace name can be substituted by the key word IMPLied. In that case the trace name defined by CALCulate:FEED is applicable.

Limitations:

CH3, CH4, Mi_3, and Mi_4 cannot be used in an expression for the PM33x0A CombiScope instruments.

Example:

Send → `CALCulate2:MATH (CH1+CH2)`	Selects MATH2 channel 1 + 2.
Send → `CALCulate2:MATH:STATe ON`	Switches MATH2 function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:MATH:STATe

Syntax: CALCulate<n>:MATH:STATe <Boolean>

<n> [1] | 2

Query form: CALCulate<n>:MATH:STATe?

Response: 0 | 1

0 Mathematics function turned off.

1 Mathematics function turned on.

Description:

This command switches the specified mathematics function on or off. If the mathematics function is switched on, the internal scale and offset are reset to initial values. The result of the mathematics function is stored in M1_1 for CALCulate1 and in M2_1 for CALCulate2.
After a *RST command, the mathematics function is turned off.

Example:

Send → `CALCulate:MATH (CH1-CH2)`	Selects MATH1 channel 1 - 2.
Send → `CALCulate:MATH:STATe ON`	Switches MATH1 function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:TRANsform:FREQuency:STATe
CALCulate<n>:TRANsform:FREQuency:TYPE
CALCulate<n>:TRANsform:FREQuency:WINDow

Syntax: CALCulate<n>:TRANsform:FREQuency:STATe <Boolean>
CALCulate<n>:TRANsform:FREQuency:TYPE ABSolute |
RELative
CALCulate<n>:TRANsform:FREQuency:WINDow RECTangular |
HAMMing | HANNing

<n> [1] | 2

Query form: CALCulate<n>:TRANsform:FREQuency:STATe?

Response: 0 | 1

Query form: CALCulate<n>:TRANsform:FREQuency:TYPE?

Response: ABS | REL

Query form: CALCulate<n>:TRANsform:FREQuency:WINDow?

Response: RECT | HAMM | HANN

Description:

The CALCulate<n>:TRANsform:FREQuency:TYPE command selects between RELative and ABSolute FFT calculation.

The CALCulate<n>:TRANsform:FREQuency:WINDow command defines the window type that is used with the FFT function. The FFT RECTangular function transforms a repetitive time amplitude trace into its power spectrum. Displayed is the amplitude (vertical) versus the frequency (horizontal). The FFT HAMMing and HANNing functions reduce the side lobes by applying a Hamming or Hanning window to the input signal. This improves the visibility of the minor frequency components if the MATH1/MATH2 - FFT - PARAM "limited area" function is not accurately selected.

The result of the FFT function is stored in M1_1 for CALCulate1 and in M2_1 for CALCulate2. After a *RST command, the FFT type is RELative, the FFT window is RECTangular, and the FFT functions are switched OFF.

Example:

```
Send → CALCulate2:TRANsform:FREQuency:TYPE RELative
```
Selects relative MATH2-FFT calculation.

```
Send → CALCulate2:TRANsform:FREQuency:WINDow HANNing
```
Selects MATH2-FFT-HANNing window.

```
Send → CALCulate2:TRANsform:FREQuency:STATe ON
```
Switches MATH2-FFT on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALCulate<n>:TRANsform:HISTogram:STATe

Syntax: CALCulate<n>:TRANsform:HISTogram:STATe <Boolean>

<n> [1] | 2

Query form: CALCulate<n>:TRANsform:HISTogram:STATe?

Response: 0 | 1

0 Histogram function turned off.

1 Histogram function turned on.

Description:

This command switches the HISTogram function on or off. The result of the histogram function is stored in M1_1 for CALCulate1 and in M2_1 for CALCulate2.
After a *RST command, the histogram function is turned off.

Example:

`Send → CALCulate:TRANsform:HISTogram:STATe ON`	Switches the histogram function on.

Front panel compliance:

The CALCulate1 and CALCulate2 commands use the MATH1 and MATH2 features of the CombiScope instrument.

CALibration[:ALL]

Syntax: CALibration[:ALL]

Query form: CALibration[:ALL]?

Response: 0 | 1

Description:

The CALibration command performs an automatic internal self-calibration. No external means or operator interface is needed. The CALibration command is an overlapped command, which means that during calibration the "Calibrating" bit (0) in the OPERation status can be read to check whether calibration has finished or not. If bit 0 = 0, calibration has finished. If bit 0 = 1, calibration is still busy. A possible calibration error is reported via bit 8 in the QUEStionable status. If bit 8 = 0, calibration was successful. If bit 8 = 1, calibration went wrong.

The CALibration? query performs an automatic internal self-calibration and reports the result of that calibration. Also no external means or operator interface is needed. The response indicates whether or not the instrument completed the self-calibration without error. A response of 0 indicates that the calibration executed successfully. A response of 1 indicates that the calibration was not successful. The CALibration? query is the equivalent of the *CAL? query.

Limitation:

The calibration process lasts a couple of minutes. During this time bit 0 in the OPERation status is set, indicating that calibration is busy. This status information can only be requested, if the calibration was started via the CALibration command. This is because the CALibration? query is a sequential command. So, the next command or query in the same program message is not executed until the calibration process is completed. Until then, no response to the next query is obtained.

Example:

Send → *RST	Resets the instrument.
Send → CALibration	Starts auto calibration.
Send → STATus:OPERation:CONDition?	Requests for oper. conditions.
Read ← <cond_reg>	Reads condition register.
WHILE (bit 0 of <cond_reg> = 1)	Loops while calibration busy.
Send → STATus:OPERation:CONDition?	Requests for oper. conditions.
Read ← <cond_reg>	Reads condition register.
LOOP_WHILE	
Send → STATus:QUEStionable:CONDition?	Requests for questionable conditions.
Read ← <cond_reg>	Reads condition register.

```
IF (bit 8 of <cond_reg) = 0)
 THEN Calibration_Okay
 ELSE (bit 8 of <cond_reg) = 1) Calibration_Not_okay
END_IF
```

Front panel compliance:

The CALibration command/query is the remote equivalent of the front panel CAL key.

CONFigure

Syntax: CONFigure[:VOLTage]<measure_function>
[[(<voltage_paremeters>),] <measure_paremeters>]
[,<channel_list>]

The syntax elements are specified with the MEASure? query.

Description:

The CONFigure command is part of the measurement instruction set. It sets up the instrument in order to perform the measurement as specified by the <measure_function> part in the command header.

The CONFigure command does not start the acquisition, and therefore, does not return a result. For that purpose, the CONFigure command must be followed by a READ? query (or by INItiate and FETCh?). Executing CONFigure and READ?, is equivalent to executing a MEASure? query.

The parameters provide additional information about the signal to be measured or the desired result. The oscilloscope uses these parameter values to provide the best possible settings for the specified task. When the parameters are defaulted, the oscilloscope chooses its own settings, based upon the signal to be measured and its own trade offs. After executing the CONFigure command, the instrument settings are undefined.

The default :VOLTage node specifies that the characteristic to be measured relates to a voltage signal. For example, the AC component of a voltage signal, the rise time of a voltage signal, etc.

Restrictions:

A CONFigure command may be executed only when the oscilloscope is in the digital mode (INStrument:SELect DIGital). The digital mode is selected after *RST. Executing this query when the instrument is in the analog mode, generates execution error -221,"Settings conflict; Digital mode required".

Example 1:

Send → `CONFigure:VOLTage:AC 0.6,(@2)`	Configures AC-RMS channel 2, expected voltage 600 mV.
Send → `INPut2:COUPling AC`	Channel 2 AC coupled.
Send → `READ:AC? (@2)`	Initiates + fetches AC-RMS value.
Read ← `<first measured AC-RMS value>`	
Send → `READ:AC? (@2)`	Initiates + fetches AC-RMS value.
Read ← `<second measured AC-RMS value>`	

Example 2:

Send → CONFigure:VOLTage:RISE:TIME (0.5),20,80,1E-2,(@2)

'

'Configures the rise time, expected voltage 0.5V,
'LOW ref. = 20%,
'HIGH ref. = 80%, expected time 0.01 seconds, channel 2.

'

Send → `INPut2:COUPling DC`	Channel 2 becomes DC coupled.
Send → `READ:RISE:TIME? (@2)`	Initiates + fetches the rise time of the signal on channel 2.
Read ← `<the measured rise time>`	
Send → `FETCh:FALL:TIME? (@2)`	Fetches the fall time of the signal on channel 2.
Read ← `<the measured fall time>`	

DISPlay:BRIGhtness

Syntax: DISPlay:BRIGhtness <Numeric_data> I MINimum I MAXimum

<Numeric_data>	0.0 .. 1.0	
MINimum	Equals 0.0	Trace display is fully blanked.
MAXimum	Equals 1.0	Trace display has full intensity.

Query form: DISPlay:BRIGhtness? [MINimum I MAXimum]

Response: <NR3>

<NR3>	0.00E00 ... 1.00E00

Description:

The command sets and the query returns the brightness of the trace display. The number 0.0 (MINimum) gives the lowest brightness. The number 1.0 (MAXimum) gives the highest brightness.
Notice that the intensity of text display is not controlled with this command.
After a *RST command, the brightness is set at 1.80E-01, i.e., 0.18.

Example:

`Send → DISPlay:BRIGhtness 0.5` Sets trace brightness at 0.5.

Front panel compliance:

The DISPlay:BRIGhtness command is the remote equivalent of the front panel TRACE INTENSITY knob.

DISPlay:MENU[:NAME]

Syntax: DISPlay:MENU[:NAME] <charecter_data>

<character_deta>	FRONT PANEL SOFTKEY NAME	
TBMode	TB MODE	(main time base)
TRIGger	TRIGGER	
DMODe	DTB	(delayed time base)
SETups	SETUPS	
CURSors	CURSORS	
ACOuire	ACQUIRE	
DISPlay	DISPLAY	
MATH	MATH	
MEASure	MEASURE	
SAVE	SAVE	
RECall	RECALL	
UTIL	UTILITY	
VERTical	VERT MENU	

Description:

The DISPlay:MENU command can be used to select a softkey menu by specifying a predefined name. Additionally, the display of the softkey menu field is switched ON. So, the execution of the DISPlay:MENU command is coupled to the execution of the DISPlay:MENU:STATe ON command. The menus ACOuire, DISPlay, MATH, MEASure, SAVE, and RECall are available in the digital mode. If they are specified in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.
After a *RST command, the mode is set at TBMode without display of the TB MODE softkey menu field.

Example:

`Send → DISPlay:MENU TBMode` Selects and displays the TB MODE softkey menu.

Front panel compliance:

The DISPlay:MENU command is the remote equivelent of the front panel menu buttons TB MODE, TRIGGER, DTB, SETUPS, CURSORS, ACQUIRE, DISPLAY, MATH, MEASURE, SAVE, RECALL, UTILITY, and VERT MENU.

DISPlay:MENU:STATe

Syntax: DISPlay:MENU:STATe <Boolean>

Query form: DISPlay:MENU:STATe?

Response: 0 | 1

0 Display turned off.

1 Display turned on.

Description:

Switches the display of the softkey menu field on or off.
After a *RST command, the display is turned off.

Example:

`Send → *RST`	Selects TB MODE menu with display off.
`Send → DISPlay:MENU:STATe ON`	Switches TB MODE menu display on.

Front panel compliance:

The DISPlay:MENU:STATe command remotely enables one of the front panel menus TB MODE, TRIGGER, DTB, SETUPS, CURSORS, ACQUIRE, DISPLAY, MATH, MEASURE, SAVE, RECALL, UTILITY or VERT MENU.

DISPlay:WINDow[1]:TEXT<n>:DATA?

Syntax: DISPlay:WINDow[1]:TEXT<n>:DATA?

[1] Indicates that the measurement result field is window 1.

<n> 1 | 2 | 10 | 11 | 12 | 13 | 20 | 21 | 30 | 40 | 51 | 52 | 60 | 61

1 MEAS1 result is returned.
2 MEAS2 result is returned.
10 Delta-V/Delta-Y is returned under the following conditions:

TYPE:	ANALOG MODE:	DIGITAL MODE:
Delta-V	X-deflection off	X versus Y off
Delta-Y	X-deflection on	X versus Y on

11 V1 is returned.
12 V2 is returned.
13 DC voltage (VDC) is returned.
20 Delta-T is returned under the following conditions:

TYPE:	ANALOG MODE:	DIGITAL MODE:
Delta-T	X-deflection off	X versus Y off

21 Frequency (1 / delta-T) is returned.
30 Delta-X is returned under the following conditions:

TYPE:	ANALOG MODE:	DIGITAL MODE:
Delta-X	X-deflection on	X versus Y on

40 The phase between 2 channels is returned.
51 T1-trg is returned.
52 T2-trg is returned.
60 FFT frequency in Hz is returned.
61 FFT amplitude is returned expressed in:
- dB (relative value)
- dBm, dbμV, or Vrms (absolute value)

Response: <ASCII_data>

<ASCII_data> A sequence of 7-bit ASCII characters.
Example:
```
Send → DISPlay:WINDow:TEXT1:DATA?
Read ← pkpk,6084E-04,V
```
Response is peak-peak value of 608.4 mV (MEAS1).

Description:

The DISPlay:WINDow[1]:TEXT<n>:DATA? query returns the measured data as displayed on the upper line(s) of the screen of your CombiScope instrument.

The measurement data functions must be enabled first, or the error message -221 "Settings conflict" is generated. If the oscilloscope is in the analog mode, the error message -221 "Settings conflict;Digital mode required" is generated. The following measurement data values can be selected by specifying the number <n> in the query:

NUMBER <n>:	MEASUREMENT VALUE:
1, 2	MEAS1, MEAS2 data
10,11,12,13,20,21,30,40,51,52	CURSORS data
60, 61	MATH - FFT frequency, amplitude

MEAS1 and MEAS2 data measurement functions can only be selected and enabled via the front panel MEASURE key and softkey menu.

CURSORS data measurement functions can only be selected and enabled via the front panel CURSORS key and softkey menu.

MATH - FFT data measurement functions can be selected and enabled via the front panel MATH/CURSORS keys and softkey menus, or by programming:

- CALCulate:TRANsform:FREQuency:TYPE ABSolute Selects abs. values.
- CALCulate:TRANsform:FREQuency:TYPE RELative Selects rel. values.
- CALCulate:TRANsform:FREQuency:STATe ON Enables MATH1 - FFT.

Note: The result of an FFT can be expressed as a relative or an absolute amplitude value. A relative FFT calculation consists of a frequency (Hz) and an amplitude in (dB). An absolute FFT calculation consists of a frequency (Hz) and an amplitude in dBm (dB with respect to 1 milliwatt), dBµV (dB with respect to 1 microvolt), or Vrms (Volt RMS) as selected via the front panel CURSORS - READOUT softkey menu.

Example:

```
Send → DISPlay:MENU MEASure              Switches MEASURE menu
                                         display on.
'*****
'Enable and define the MEAS1 function via the front panel
'MEASURE menu.
'*****
Send → DISPlay:WINDow:TEXT1:DATA?  Queries MEAS1 result.
Read → <MEAS1_result>
PRINT <MEAS_result>
```

Front panel compliance:

The DISPlay:WINDow[1]:TEXT<n>:DATA? query is the remote equivalent of the front penel CURSORS, MATH, and MEASURE keys end softkey menus.

DISPlay:WINDow2:TEXT[1]:CLEar

Syntax: DISPlay:WINDow2:TEXT[1]:CLEar

2 Indicates that the user text field is window 2.

[1] Is optional and has no meaning.

Description:

This command clears the contents of the user text field from the screen of the oscilloscope. The result is that the user text is no longer displayed.

Example:

`Send → DISPlay:WINDow2:TEXT:STATe ON`	Enables display of text.
`Send → DISPlay:WINDow2:TEXT:CLEar`	Clears all user text.

Front panel compliance:

The DISPlay:WINDow2:TEXT:CLEar command is the remote equivalent of the "delete user text" option of the front panel DISPLAY - TEXT menu.

DISPlay:WINDow2:TEXT[1]:DATA

Syntax: DISPlay:WINDow2:TEXT[1]:DATA <string_data> | <block_data>

2	Indicates that the user text field is window 2.
<string_data>	Maximum 64 characters. Examples: "this is a string" 'this also'
<block_data>	Maximum 64 data bytes. Examples: #01.25 k↓ (indefinite length) #171.25 k↓ (definite length)

The result of both examples is, that 1.25 kΩ will be displayed. Take notice that character ↓ has decimal value 25, which represents the character Ω on the oscilloscope screen.

Description:

This command writes data into the user text field. The result is that the data is displayed on the two text lines of the screen of the oscilloscope. The first character or data byte is positioned on the first position of the first text line. The 64th character or data byte is placed on the last position of the second text line. Keyboard characters (directly entered via the keyboard of your controller) can be sent as <string_data>. Non-keyboard characters must be sent as <block_data>. The table on the next page shows the character set of the CombiScopes instruments.

Example 1:

Display on the screen of the oscilloscope the text: **"Remote control via PC"**

`Send → DISPlay:WINDow2:TEXT:STATe ON`	Enables display of text.
`Send → DISPlay:WINDow2:TEXT:DATA '"Remote control via PC"'`	

Example 2:

Display on the screen of the oscilloscope the text: **1.25 kΩ (CH1)**

`Send → DISPlay:WINDow2:TEXT:STATe ON`	Enables display of text.
`Send → DISPlay:WINDow2:TEXT:DATA #01.25 k`	Sends header + 1.25 k as text.
`Send → <byte(25)>`	Sends 25 decimal (= symbol Ω) as single character byte.
`Send → (CH1)`	Sends space, followed by (CH1).

Front panel compliance:

The DISPlay:WINDow2:TEXT:DATA command is the remote equivalent of the "insert user text" option of the front panel DISPLAY - TEXT menu.

dec	sym	dec	sym	dec	sym	dec	sym	dec	sym	dec	sym	dec	sym	dec	sym
0	....	16		32		48	0	64	@	80	P	96	►	112	p
1	..	17		33	!	49	1	65	A	81	Q	97	a	113	q
2	⁝	18		34	"	50	2	66	B	82	R	98	b	114	r
3	:	19	X	35	#	51	3	67	C	83	S	99	c	115	s
4	.	20	X	36	$	52	4	68	D	84	T	100	d	116	t
5		21	⌂	37	%	53	5	69	E	85	U	101	e	117	u
6		22	°	38	&	54	6	70	F	86	V	102	f	118	v
7		23	µ	39	'	55	7	71	G	87	W	103	g	119	w
8		24		40	(	56	8	72	H	88	X	104	h	120	x
9		25	Ω	41	)	57	9	73	I	89	Y	105	i	121	y
10		26	↑	42	*	58	:	74	J	90	Z	106	j	122	z
11		27	↓	43	+	59	;	75	K	91	[	107	k	123	◄
12		28	~	44	,	60	<	76	L	92	\	108	l	124	¦
13		29	⊥	45	-	61	=	77	M	93	]	109	m	125	▲
14		30	⊙	46	.	62	>	78	N	94	^	110	n	126	▼
15		31	●	47	/	63	?	79	O	95	_	111	o	127	⬍

Table 4.1 Display character set for CombiScope instruments

Notes:
- *The left value (dec) is the decimal value of the code and the right value (sym) is the oscilloscope symbol.*
- *The displayed symbol for the decimal values 128 to 255 is equal to the symbol display for the decimal values 0 to 127.*
  Example: Decimal value 200 = decimal value 72 (200-128) = symbol H.
- *For the PM33x0A CombiScope instruments the $ symbol (dec. 36) is replaced by the* E_T *symbol (External Trigger)*

DISPlay:WINDow2:TEXT[1]:STATe

Syntax: DISPlay:WINDow2:TEXT[1]:STATe <Boolean>

2 Indicates that the user text field is window 2.

Query form: DISPlay:WINDow2:TEXT[1]:STATe?

Response: 0 | 1

0 Display turned off.

1 Display turned on.

Description:

Switches the display of the user text field on or off.
After a *RST command, the display of user text is turned off.

Example:

Send → `DISPlay:WINDow2:TEXT:STATe OFF`	Turns off the display of the user text.

Front panel compliance:

The DISPlay:WINDow2:TEXT:STATe command is the remote equivalent of the "user text on/off" option of the front panel DISPLAY - TEXT menu.

FETCh?

Syntax: FETCh[:VOLTage]<measure_function>?
[[(<voltege_parameters>),] <measure_peremeters>]
[,<channel_list> | <trece_list>]

<trace_list> = (@<trece_name>)

<trece_name> = <ecquisition_trace> | <memory_trace>

<acquisition_trace> = CH1 | CH2 | CH3 | CH4
These are predefined names for traces that contain the acquisition result of the input channels 1 to 4.
Note: CH3 and CH4 not for PM33x0A

<memory_trace> = M<i>_<j>
These are predefined names for traces that may contain the result of previous acquisitions or the result of CALCulate processes.

<i> = Integer value in the range 1 to 50 that specifies the trace memory register number.
<i> = 1 to 8: standard memory
<i> = 9 to 50: extended memory

<j> = Integer value in the range 1 to 4 that specifies the sequence number of the channel trace in the memory register.
Note: <j>=3 and <j>=4 not for PM33x0A

The other syntax elements are specified with the MEASure? query.

Response: <NR3)

Example: <1.25E-01> = 0.125

Description:

The FETCh? queries are part of the measurement instruction set. They return the signal characteristic from the last initiated measurement, as specified by the <measure function> part of the query header.

An initiate command must precede a FETCh? query. The initiate command may be given either explicitly as INITiate[:IMMediate] command, or explicitly by a READ? or MEASure? query. When the acquisition is still in progress, the response to a FETCh? query does not become available until the acquisition is completed. In such a case, no error is reported. Execution of INITiate[:IMMediate] and FETCh? is equivalent to the execution of the READ? query.

A FETCh? query may also return a signal characteristic from a valid acquisition result that is stored in a TRACe memory element.
Example: Send → FETCh:AC? (@M2_3) Fetches AC- RMS of the M2_3 trace.

A FETCh? query allows the same parameter sets as the corresponding MEASure? and CONFigure instructions. Their use distinguishes from these instructions in that they only serve to specify the desired result from a FETCh? query. They don't affect the instrument settings. They may also be sent for reasons of compatibility with a preceding CONFigure or READ? instruction.

When the <measure_function> part of the FETCh? query header is defaulted, the characteristic as specified by the last executed FETCh?, READ?, or MEASure query is returned. When such a query is not executed since the last power on cycle, the measure function VOLTage:DC is assumed by the oscilloscope.

The default :VOLTage node specifies that the requested characteristic relates to the voltage component of the signal. For example, the rise time or the frequency of the voltage.

Restrictions:

(1) A FETCh? query may be executed only when the oscilloscope is in the digital mode (INStrument:SELect DIGital). The digital mode is selected after *RST. Executing this query when the instrument is in the analog mode generates execution error -221,"Settings conflict; Digital mode required".

(2) A FETCh? query may not operate on a TRACe memory element that has been modified since the last executed INItiate[:IMMediate], READ?, or MEASure? command. Otherwise execution error -230,"Data corrupt or stale" is generated.

Example 1:

Send → MEASure:VOLTage:AC? 0.6,(@2)	Measures AC- RMS on channel 2, expected voltage 600 mV.
Read ← <the measured AC-RMS value>	
Send → FETCh:DC? (@2)	Fetches the DC component.
Read ← <the measured DC component>	
Send → FETCh:AMPLitude? (@2)	Fetches the waveform amplitude.
Read ← <the measured amplitude>	

Example 2:

Send → CONFigure:AC	Configures for AC-RMS.
Send → TRIGger:SOURce BUS	Trigger source GPIB.
Send → SENSe:VOLTage:RANGe:OFFSet .25	250 millivolt offset.
Send → INITiate	Initiates trigger system.
Send → *TRG	Triggers (GET) via GPIB.
Send → FETCh:AC?	Fetches AC-RMS value.
Read ← <the measured AC-RMS voltage>	

Note: *Because the trigger source is BUS (GPIB), the GET (Group Execute Trigger) code must be sent after INITiate and before FETCh? to trigger the acquisition.*

Errors:

(1) When a FETCh? query is executed and no valid acquisition data is available, nor an acquisition pending, execution error -230, "Data corrupt or stale" is generated. In that case, no result is returned as response to the FETCh? query.

(2) When a FETCh? query for a characteristic from a TRACe memory element is received, which does not contain valid acquisition data, execution error -230, "Data corrupt or stale" is generated.

FORMat[:DATA]

Syntax: FORMat[:DATA] INTeger[, 8 | 16]

INTeger,8	Trace point of 8 bits (one byte).
INTeger,16	Trace point of 16 bits (two bytes).

Query form: FORMat[:DATA]?

Response: INT,8 | INT,16

INT,8	Trace point consists of one byte.
INT,16	Trace point consists of two bytes.

Description:

Programs the number of bits of the trace data points. If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated. After a *RST command, the number of bits is 16.

Example:

`Send → FORMat INTeger,8`	Programs the resolution at 8 bits.
`Send → TRACe? M1_4`	Queries for trace 4 in memory register 1.
`Read ← <trace_block>`	Each trace point consists of 8 bits.

Note: *This only works when a trace was stored before in M1-4.*

HCOPy:DATA?

Syntax: HCOPy:DATA?

Response: <indefinite_block>

Description:

This query returns a data block of indefinite length containing a hardcopy of the picture on the oscilloscope display, according to the current printer/plotter selections. These selections can be made through the UTIL - PRINT & PLOT softkey menu options. The received data block can be sent to a supported plotter or printer via the IEEE bus or the EIA-232-D (RS-232-C) interface to get the hardcopy. If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.

Refer to the HCOPy:DEVice command for a list of supported printers and plotters, of which two special selection possibilities:

HPGL	If this is selected, a plotter independent HPGL data block is sent, which can be used, for instance, in a Desk Top Publishing application.
DUMP_M1	This selects a special trace dump to be used in combination with one of the generators PM5138, PM5139, or PM5150 connected to the CombiScope via GPIB. This option can only be started by pressing the PLOT key on the front panel; not by sending the HCOPy:DATA? query. Also the controller must be disconnected from the GPIB and the generator must be in its "listen only" (LO) mode.

After a *RST command, the option "HPGL" is selected.

Example:

Prepare for hardcopy to a HPGL plotter.

`Send → *RST`	Selects HPGL-plotter.
`Send → HCOPy:DATA?`	Oueries for screen hardcopy data.
`Read ← <data_block>`	Reads the hardcopy data block. <data_block> = #0<hardcopy_data>NL
`Send → <hardcopy_data>`	Sends the hardcopy data block to the connected HPGL plotter.

Note: *The preamble #0 (for indefinite length block dete) at the beginning of the date block must not be sent.*

Front panel compliance:

The HCOPy:DATA? query is the remote equivalent of the PLOT key on the front panel.

HCOPy:DEVice

Syntax: HCOPy:DEVice HPGL | HP7440 | HP7550 | HP7475A| HP7470A | PM8277 | PM8278 | FX80 | LQ1500 | HP2225 | HPLASER | DUMP_M1

HPGL	HPGL plot data format.
HP7440, HP7550, HP7475A, HP7470A, PM8277, PM8278	Plotters.
FX80, HP2225, LQ1500, HPLASER	Printers.
DUMP_M1	Trace dump data format to one of the arbitrary waveform generators PM5138, PM5139, or PM5150.

Query form: HCOPy:DEVice?

Response: HPGL | HP7440 | HP7550 | HP7475A| HP7470A | PM8277 PM8278 | FX80 | LQ1500 | HP2225 | HPLASER | DUMP_M1

Description:

The HCOPy:DEVice <n> command selects a hardcopy device by specifying the device type. This selection determines the format of the hardcopy data that can be read using the HCOPy:DATA? query.
After a *RST command, the hardcopy device selection is HPGL.

Example:

`Send → *RST`	Resets the instrument.
`Send → HCOPy:DEVice PM8277`	Selects the PM8277 plotter
`Send → HCOPy:DATA?`	Requests for screen hardcopy data in PM8277 plot format.
`Read ← <data_block>`	Reads the hardcopy data block, consisting of: #0<hardcopy_data>NL

`Send <hardcopy_data> to the connected PM8277 plotter.`

Front panel compliance:

The HCOPy:DEVice command is the remote equivalent of the front panel UTILITY - PRINT/PLOT softkey menu.

INITiate:CONTinuous

Syntax: INITiate:CONTinuous <Boolean>

Query form: INITiate:CONTinuous?

Response: 1 | 0

1 Continuous automatic initiation is ON.

0 Continuous automatic initiation is OFF.

Description:

The INITiate:CONTinuous command selects whether the trigger system is continuously initiated or not. When INITiate:CONTinuous is ON, the trigger system is continuously initiating acquisitions. This can only be stopped by setting INITiate:CONTinuous to OFF or by sending *RST. The ABORt command stops the current acquisition, but doesn't affect the setting of INITiate:CONTinuous. Therefore, new acquisitions are initiated immediately.
After a *RST command, INITiate:CONTinuous OFF is valid.

PROGRAMMING NOTES:

- During INITiate:CONTinuous ON the trigger system remains initiated (does not return to the IDLE state). This implies that when an *OPC command is given, bit 0 (OPC) in the standard Event Status Register (ESR) will never be set. Neither the response to an *OPC? query will be generated, which causes a hang-up of the CombiScope when the response is read.
- After receiving one of the commands INITiate or INITiate:CONTinuous ON, the oscilloscope checks the following *RST trigger settings:
  - X-deflection OFF
  - Del'd TB OFF
  - Trigger Edge
  - Level-PP OFF
  - X vs Y OFF
  - Roll mode OFF } digital mode
  - Event delay OFF } digital mode
  - Peak detection OFF } digital mode

  In case of a settings conflict, the command is ignored and error -221 "Settings conflict" is reported. To avoid this , first send a *RST command before sending an INITiate command.

Example:

`Send → *RST`	Resets the instrument.
`Send → CONFigure:AC (@1)`	Configures for AC channel 1.
`Send → INITiate:CONTinuous ON`	Continuous initiation.
`Send → FETCh:AC?`	Fetches AC-RMS value.
`Read ← <AC-RMS voltage>`	Reads AC-RMS voltage.

INITiate[:IMMediate]

Syntax: INITiate[:IMMediate]

Description:

This command causes the trigger system to be initiated once only, i.e., initiates one acquisition cycle. The actual acquisition starts when all trigger conditions have been met. After the acquisition has completed, the trigger system returns to the IDLE state.

Note: *The OPERation status bits 3 (SWEeping) and 5 (Waiting for TRIGger) are valid when INITiate:CONTinuous is OFF and:*
- *the trigger mode is single-shot (TB MODE - single).*
- *the trigger mode is multiple-shot (TB MODE - multi).*

Example:

`Send → *RST`	Resets the instrument.
`Send → TRIGger:SOURce INTernal1`	Trigger source becomes channel 1.
`Send → TRIGger:LEVel .2`	Trigger level becomes 0.2V.
`Send → INITiate`	Single shot acquisition.
`Send → TRACe? CH1`	Queries channel 1 trace.
`Read ← <acquisition trace channel 1>`	

Note: *For single-shot averaged acquisitions the trigger source must be one of the input shannels (INTerval <n>), instead if IMMediate (software automatic trigger).*

Errors:

When an INITiate command is given while the trigger system is not in the IDLE state, the message -213,"Init ignored" is generated.

INPut<n>:COUPling

Syntax: INPut<n>:COUPling AC | DC | GROund

<n> [1] | 2 | 3 | 4

Query form: INPut<n>:COUPling?

<n> [1] | 2 | 3 | 4

Response: AC | DC | GRO

Description:

Selects the vertical input coupling of a specified <n> input channel. If AC is specified, the DC offset value is excluded. If DC is specified, the DC offset value is included. If GROund is specified, the AC value is grounded (zeroed).
After a *RST command, the coupling is DC.

Restrictions:

For the PM3382A and PM3392A CombiScope instruments the coupling of the input channels 3 and 4 can only be set to AC or DC.
For the PM33x0A CombiScope instruments channel 3 is not applicable, and the input coupling of channel 4 can only be set to AC or DC.

Example:

Send → `*RST`	Resets the instrument (DC coupled).
Send → `CONFigure:AC (@2)`	Configures for channel 2 AC-RMS.
Send → `SENSe:FUNCtion "XTIMe:VOLTage2"`	Sets channel 2 ON.
Send → `READ:AC? (@2)`	Reads AC-RMS on channel 2.
Read ← `<AC-RMS +DC-offset voltage>`	
Send → `INPut2:COUPling AC`	Couples true AC-RMS.
Send → `READ:AC? (@2)`	Reads AC-RMS on channel 2.
Read ← `<AC-RMS voltage>`	
Send → `INPut2:COUPling GROund`	Couples to ground.
Send → `READ:AC? (@2)`	Reads AC-RMS on channel 2.
Read ← `<AC-RMS ground level voltage>`	

Front panel compliance:

The INPut<n>:COUPling command is the remote equivalent of the front panel AC/DC/GND key.

INPut<n>:FILTer[:LPASs][:STATe]
INPut<n>:FILTer[:LPASs]:FREQuency?

Syntax: INPut<n>:FILTer[:LPASs][:STATe] <Boolean>

<n> [1] | 2 | 3 | 4

INPut<n>:FILTer[:LPASs]:FREQuency? [MINimum | MAXimum]

MINimum Fixed at 20 MHz

MAXimum Fixed at 20 MHz

Note: Channel 3 is not applicable for PM33x0A.

Response: 2.00E+07

Query form: INPut<n>:FILTer[:LPASs][:STATe]?

Response: 0 | 1

0 Common low pass filter off.

1 Common low pass filter on.

Description:

The INP<n>:FILT command turns the common low-pass filter ON or OFF for all input channels, independent of the value of <n>.
The INP<n>:FILT:FREQ? query returns the cutoff frequency of the common low-pass filter, which is fixed at 20 MHz (not programmable). The filter can be turned ON or OFF with the INPut[<n>]:FILTer[:LPASs][:STATe] command. The common low-pass filter is called bandwidth limiter on the front panel (BW LIMIT option in the VERT MENU menu).
After a *RST command, the filter is turned OFF.

Example:

Send → `INPut:FILTer ON` Turns the filter ON.

Front panel compliance:

The INPut<n>:FILTer[:LPASs][:STATe] command is the remote equivalent of the front panel BW LIMIT option in the VERT MENU menu.

INPut<n>:IMPedance

Syntax: INPut<n>:IMPedance <NRf> | MINimum | MAXimum

<n> [1] | 2 | 3 | 4

<NRf> 50 | 1E6

<MINImum> Equals 5.00E+01 (50Ω)

<MAXimum> Equals 1.00E+06 (1 MΩ)

Note: Channel 3 is not applicable for PM33x0A.

Query form: INPut<n>:IMPedance? [MINimum] | [MAXimum]

<n> [1] | 2 | 3 | 4

Response: 5.00E+01 | 1.00E+06

If <MINimum> was specified, 5.00E+01 (50Ω) is returned.

If <MAXimum> was specified, 1.00E+06 (1 MΩ) is returned.

Description:

The input impedance of channel <n> is set according to the impedance parameter specified. The impedance can be specified low (50Ω) or high (1 MΩ).
After a *RST command, the impedance is 1 MΩ.

Restrictions:

The impedance of the following input channels is fixed at 1 MΩ:
- All channels of the PM3382A and PM3384A CombiScopes instruments.
- The channels 3 and 4 of the PM3392A CombiScope instrument.
- Channel 4 of the PM33x0A CombiScope instruments.

Example:

`Send → INPut2:IMPedance 50` Selects 50Ω input impedance for channel 2.

Front panel compliance:

The INPut<n>:IMPedance command is the remote equivalent of the front panel 50Ω option in the VERT MENU menu.

INPut<n>:POLarity

Syntax: INPut<n>:POLarity NORMal | INVerted

<n> 2 | 4

Note: Input 4 is not applicable for PM33x0A.

Query form: INPut<n>:POLarity?

<n> 2 | 4

Response: NORM | INV

Description:

The INPut<n>:POLarity command sets the polarity of the signal on the input channels two and four. The polarity can be set to NORMal (default) or INVerted (inverted signal).
After a *RST command, the polarity is NORMal.

Example:

Send → *RST	Resets the instrument.
Send → CONFigure:AC (@2)	Configures channel 2.
Send → SENSe:FUNCtion "XTIMe:VOLTage2"	Sets channel 2 ON.
Send → INPut2:COUPling DC	Sets DC input coupling on.
Send → INPut2:POLarity INVerted	Sets INV CH2 on.
Send → READ:DC? (@2)	Requests DC channel 2.
Read ← <DC value>	Reads inverted DC value.

Front panel compliance:

The INPut<n>:POLarity command is the remote equivalent of the front panel INV keys.

INSTrument:NSELect
INSTrument[:SELect]

Syntax: INSTrument:NSELect <NRf> | MINimum | MAXimum
INSTrument[:SELect] DIGital | ANALog

<NRf>	1 | 2
1 | MINimum	The digital mode (DSO) is activated.
2 | MAXimum	The analog mode is activated.
DIGital	The digital mode (DSO) is activated.
ANALog	The analog mode is activated.

Query form: INSTrument:NSELect? [MINimum | MAXimum}

Response: 1 | 2

1	The digital mode (DSO) is active. This is also returned when MAXimum is specified.
2	The analog mode is active. This is also returned when MINimum is specified.

Query form: INSTrument[:SELect]?

Response: DIG | ANAL

DIG	The digital mode (DSO) is active.
ANAL	The analog mode is active.

Description:

Selects the analog or digital mode of the CombiScope by specifying a predefined number or name. When one mode is selected, the other mode is deactivated. After a *RST command, the digital mode (DSO) is selected.

Example:

`Send → INSTrument:NSELect 2`	Analog mode is selected.
`Send → INSTrument DIGital`	Digital mode is selected.

Front panel compliance:

These commands are the remote equivalent of the front panel ANALOG key.

MEASure?

Syntax: MEASure[:VOLTage]<measure_function>?
[[(<voltage_paremeters>),] <measure_parameters>]
[,<chennel_list>]

<voltage_parameters> = [<expected_voltage> [,<resolution>]]

<expected_voltage> = <NRf> I DEFault

Specifies the voltage that is expected at the input.

<resolution> = <NRf> I DEFault

This parameter may be added for reasons of compatibility with similar programs for other instruments. It would specify the resolution of the result when a voltage measurement is to be executed. Because the CombiScope has a fixed resolution, this parameter is ignored during execution.
Both voltage parameters must be omitted when the :VOLTage node of the command is defaulted.

<channel_list> = [(@1)] I (@2) I (@3) I (@4)

Specifies the input channel number at which the characteristic is to be measured.

Note: @3 and @4 not applicable for PM33x0A.

<measure_function>	**<measure_parameters>**
:AC	No parameters. Measures the RMS value of the AC component. The RMS value is expressed in volts.
:AMPLitude	No parameters. Measures the amplitude of a waveform. The amplitude is the difference between the HIGH and LOW values as shown in figure 3.2. The amplitude is expressed in volts.
[:DC]	No parameters. Measures the DC component. The DC component is expressed in volts.

:FALL:OVERshoot — No parameters. Measures the overshoot of the first falling edge of a waveform, expressed as a percentage of the waveform AMPLitude. The fall overshoot is the difference between the LOW value and the MINimum negative peak value to which the signal initially falls, as shown in figure 3.2. The overshoot value in volts is calculated as follows:

overshoot_value = overshoot_percentage * AMPLitude / 100

:FALL:PREShoot — No parameters. Measures the preshoot of the first falling edge of a waveform, expressed as a percentage of the waveform AMPLitude. The fall preshoot is the difference between the HIGH value and the MAXimum positive peak value to which the signal initially rises, as shown in figure 3.2. The preshoot value in volts is calculated as follows:

preshoot_value = preshoot_percentage * AMPLitude / 100

:FALL:TIME — [<reference_low> [,<reference_high> [,<expected_time> [,<time_resolution>]]]

Measures the fall time of the first falling edge of a waveform. This is the time interval during which the instantaneous signal value decreases from the REFerence HIGH to the REFerence LOW value, as shown in figure 3.2. The fall time is expressed in seconds. FTIMe is an alias of FALL:TIME.

:FREQuency — [<expected_frequency> [,<frequency_resolution>]]

Measures the frequency of the input signal. The frequency is the inverse of the PERiod as shown in figure 3.2. The frequency is expressed in hertz.

:HIGH — No parameters. Measures the HIGH value of the waveform, as shown in figure 3.2. The HIGH value is the more positive of the BASE and TOP signal as defined by the standards IEC 469 and IEEE 194. The HIGH value is expressed in volts.

:LOW — No parameters. Measures the LOW value of the waveform, as shown in figure 3.2. The LOW value is the less positive of the BASE and TOP signal as defined by the standards IEC 469 and IEEE 194. The LOW value is expressed in volts.

:MAXimum — No parameters. Measures the MAXimum instantaneous voltage value of the waveform. The unit of MAXimum is volt.

:MINimum

No parameters. Measures the MINimum instantaneous voltage value of the weveform. The unit of MINimum is volt.

:NDUTycycle

<reference_middle>

Measures the negative duty cycle. The negative duty cycle is the ratio (percentege) of the negative width (NWIDth) and the PERiod of the waveform, es shown in figure 3.2.

:NWIDth

<reference_middle>

Measures the negative width, which is the time duration of the negative pulse. This time period extends from the moment that the first falling edge equals the REFerence MIDDle until the next rising edge equals the same reference level, as shown in figure 3.2. The negative width is expressed in seconds.

:PDUTycycle

<reference_middle>

Measures the positive duty cycle. The positive duty cycle is the ratio (percentage) of the positive width (PWIDth) and the PERiod of the waveform, as shown in figure 3.2. DCYCle is an alias of PDUTycycle.

:PERiod

[<expected_period> [,<period_resolution>]]

Measures the period of the input signal. The period is the inverse of the FREQuency and is expressed in seconds.

:PTPeak

No parameters. Measures the peak to peak value of the input signal. The peak to peak value is the difference between the MAXimum and MINimum value of the waveform. The PTPeak value is expressed in volts.

:PWIDth

<reference_middle>

Measures the positive width, which is the time duration of the positive pulse. This time period extends from the moment that the first rising edge equals the REFerence MIDDle until the next falling edge equals the same reference level, as shown in figure 3.2. The positive width is expressed in seconds.

:TMAXimum

No paremeters. Meesures the time of the first occurrence of the MAXimum voltege of the input signel. The unit of TMAXimum is seconds.

:TMINimum — No parameters. Measures the time of the first occurrence of the MINimum voltage of the input signal. The unit of TMINimum is seconds.

:RISE:OVERshoot — No parameters. Measures the overshoot of the first rising edge of a waveform, expressed as a percentage of the waveform AMPLitude. The rise overshoot is the difference between the HIGH value and the MAXimum positive peak value to which the signal initially rises, as shown in figure 3.2. The overshoot value in volts is calculated as follows:

overshoot_value = overshoot_percentage * AMPLitude / 100

:RISE:PREShoot — No parameters. Measures the preshoot of the first rising edge of a waveform, expressed as a percentage of the waveform AMPLitude. The preshoot is the difference between the LOW value and the MINimum negative peak value to which the signal initially false, as shown in figure 3.2. The preshoot value in volts is calculated as follows:

preshoot_value = preshoot_percentage * AMPLitude / 100

:RISE:TIME — [<reference_low> [,<reference_high> [,<expected_time> [,<time_resolution>]]]

Measures the rise time of the first rising edge of a waveform. This is the time interval during which the instantaneous signal value increases from the REFerence LOW to the REFerence HIGH value, as shown in figure 3.2. The rise time is expressed in seconds. RTIMe is an alias of RISE:TIME.

<measure_parameters>

<reference_low> = <NRf> I DEFault

Range: 0 ... 100. Default value: 10
Specifies the REFerence LOW level as a percentage of the HIGH value. See figure 3.2. The unit of <reference_low> is volt.

<reference_high> = <NRf> I DEFault

Range: 0 ... 100. Default value: 90
Specifies the REFerence HIGH level as a percentage of the HIGH value. See figure 3.2. The unit of <reference_high> is volt.

<expected_time> =	<NRf> I DEFault Specifies the time value that is expected to be measured. The unit of <expected_time> is second.
<time_resolution> =	<NRf> I DEFault Specifies the resolution of the time measurement to be executed. The unit of <time_resolution> is second.
<expected_frequency> =	<NRf> I DEFault Specifies the frequency value that is expected to be measured. The unit of <expected_frequency> is hertz.
<frequency_resolution =	<NRf> I DEFault Specifies the resolution of the frequency measurement to be executed. The unit of <frequency_resolution> is hertz.
<reference_middle> =	<NRf> I DEFault Range: 0 ... 100. Default value: 50 Specifies the REFerence MIDDle level as a percentage of the HIGH value. See figure 3.2. The unit of <reference_middle> is volt.
<expected_period> =	<NRf> I DEFault Specifies the value of the period that is expected to be measured. The unit of <expected_period> is second.
<period_resolution> =	<NRf> I DEFault Specifies the resolution of the period measurement to be executed. The unit of <period_res> is second.
Response:	<NR3> Example: <1.25E-01> = 0.125

Limitations:

The oscilloscope is only able to calculate rise and fall time characteristics, if the <low_reference> and <high_reference> parameters are limited to 1/8 division from their maximum and minimum. The limit of 0.125 divisions (noise level) depends on the vertical sensitivity of the top-to-top value (PTPeak) of the actual signal and is calculated as follows:

	<low>	<high>
- If PTPeak < 1 div., limit = 0.125 x 100% =	12.5%	87.5%
- If PTPeak < 2 div., limit = (0,125 / 2) x 100% =	6.25%	93.75%
- If PTPeak < 3 div., limit = (0,125 / 3) x 100% =	4.16%	95.84%
- If PTPeak < 4 div., limit = (0,125 / 4) x 100% =	3.125%	96.87%
- If PTPeak < 5 div., limit = (0,125 / 5) x 100% =	2.5%	97.5%
- If PTPeak < 6 div., limit = (0,125 / 6) x 100% =	2.08%	97.92%
- If PTPeak < 7 div., limit = (0,125 / 7) x 100% =	1.78%	98.22%
- If PTPeak < 8 div., limit = (0,125 / 8) x 100% =	1.56%	98.44%
- If PTPeak < 9 div., limit = (0,125 / 9) x 100% =	1.38%	98.62%
- If PTPeak < 10 div., limit = (0,125 / 10) x 100% =	1.25%	98.75%

For frequency, delay, period, and dutycycle calculations these limits are also applicable for the <middle_reference> parameter.

Notes:

(1) For reasons of compatibility with similar programs for other instruments, the syntax for the MEASure?, FETCh?, CONFigure, and READ? command allows the default node [:SCALar]. When used, this node must be placed after the leading node (MEASure, FETCh, CONFigure, or READ) but before the default [:VOLTage] node.

(2) Parenthesis around the <voltage_parameters> may be left out when no <measure_parameter> exists.

(3) A MEASure? query is always executed over the whole acquisition length of 512 samples (not cursor limited).

Description:

The MEASure? queries are part of the measurement instruction set. They provide an automatic measurement of the signal characteristics as specified by the <measure_function> part in the query header. In one operation, the instrument is configured or set up, the acquisition initiated, and the result returned. Execution of a MEASure? query aborts any pending operation.

The parameters provide additional information about the signal to be measured or the result desired. The oscilloscope uses these parameter values to provide the best possible settings for the specified task. When the parameters are defaulted, the oscilloscope chooses its own settings, based upon the signal to be measured and its own trade offs. After executing the MEASure? query, the instrument settings are undefined.

The default :VOLTage node specifies that the characteristic to be measured relates to a voltage signal. For example, the AC component of a voltage signal, the rise time of a voltage signal, etc.

Restrictions:

A MEASure? query may be executed only when the oscilloscope is in the digital mode (INStrument:SELect DIGital). The digital mode is selected after *RST. Executing this query when the instrument is in analog mode generates execution error -221,"Settings conflict; Digital mode required".

Example 1:

Send → `MEASure:VOLTage:AC? 0.6,(@2)`	Measures AC- RMS on channel 2, expected voltage 600 mV.
Read ← `<the measured AC-RMS value>`	

Example 2:

```
Send → MEASure:VOLTage:RISE:TIME? (0.6),20,80,1E-2,(@2)
'
'Measures the rise time, expected voltage 600 mV,
'LOW ref. = 20%,
'HIGH ref. = 80%, expected time 0.01 seconds, channel 2.
'
Read ← <the measured rise time>
```

Errors:

When TRIGger:SOURce BUS is selected, the execution of a MEASure? query generates execution error -214, "Trigger deadlock".

READ?

Syntax: READ[:VOLTage]<measure_function>?
[[(<voltage_parameters>),] <measure_parameters>]
[,<channel_list>]

The syntax elements are specified with the MEASure? query.

Response: <NR3>

Example: <1.25E-01> = 0.125

Description:

The READ? queries are part of the measurement instruction set. They start a measurement and return the signal characteristic that is specified by the <measure function> part in the query header. Executing a READ? query aborts any pending acquisition. The READ? query does not affect the instrument settings.

Before the READ? query, the CONFigure command must be executed, to set up the instrument for the measurement task to be performed. Executing CONFigure and READ? in order, without any command in between, is equivalent to executing the MEASure? query.

A READ? query allows the same parameter sets as the corresponding MEASure? and CONFigure instructions. Their use distinguishes from these instructions in that they only serve to specify the desired result from a READ? query. They don't affect the instrument settings. They may also be sent for reasons of compatibility with the preceding CONFigure instruction.

The default :VOLTage node specifies that the requested characteristic relates to the voltage component of the signal. For example, the rise time or frequency of the voltage.

A READ? query can be executed only when the oscilloscope is in the digital mode (INStrument:SELect DIGital). The digital mode is selected after *RST. Executing this query when the instrument is in the analog mode generates execution error -221,"Settings conflict; Digital mode required".

Note: *Because the READ? query leaves instrument settings unaffected, it can very well be used as follows to read a measured value within a cursor limited acquisition area:*

- *Press the CURSORS key on the front panel to enable the use of cursors.*
- *Set the cursor area via the CURSORS softkey menu.*
- *Send → READ:PTPeak? Queries for Peak-To-Peak measurement within the previously set cursor area.*
- *Read ← <peak-to-peak voltage>*
- *Send → FETCh:AC? Fetches AC-RMS value of latest acquisition.*
- *Read ← <AC-RMS voltage>*

Example 1:

Send → `CONFigure:VOLTage:AC 0.6,(@2)`	Configures AC-RMS channel 2, expected voltage 600 mV.
Send → `SENSe:AVERage ON`	Enables averaging
Send → `READ:AC? (@2)`	Initiates + fetches AC-RMS value.
Read ← `<averaged AC-RMS value>`	
Send → `READ:AC? (@2)`	Initiates + fetches AC-RMS value.
Read ← `<averaged AC-RMS value>`	

Example 2:

Send → `CONFigure:VOLTage:RISE:TIME (0.5),20,80,1E-2,(@2)`

'Configures the rise time, expected voltage 0.5V,
'LOW ref. = 20%,
'HIGH ref. = 80%, expected time 0.01 seconds, channel 2.

Send → `INPut2:COUPling AC`	Channel 2 becomes AC coupled.
Send → `READ:RISE:TIME? (@2)`	Initiates + fetches the rise time of the signal on channel 2.
Read ← `<the measured rise time>`	
Send → `FETCh:FALL:TIME? (@2)`	Fetches the fall time of the signal on channel 2.
Read ← `<the measured fall time>`	

Errors

Executing READ? when TRIGger:SOURce BUS is selected, generates execution error -214, "Trigger deadlock".

SENSe:AVERage[:STATe]

Syntax: SENSe:AVERage[:STATe] <Boolean>

Query form: SENSe:AVERage[:STATe]?

Response: 0 | 1

0 AVERAGE function switched off.

1 AVERAGE function switched on.

Description:

Switches the preprocessing AVERAGE function on or off. If switched on, measurement values and acquisition traces are averaged according to the average count factor (SENSe:AVERage:COUnt). Averaging is a way to suppress noise without loosing bandwidth. It can only be used for repetitive signals. If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.
After a *RST command, the AVERAGE function is switched off.

Example:

Send → `*RST`	Resets the instrument Trigger source to IMMediate
Send → `CONFigure:AC`	Configures for AC-RMS.
Send → `TRIGger:INTernal 1`	Makes channel 1 the trigger source.
Send → `SENSe:AVERage:COUNt 16`	Average count factor becomes 16.
Send → `SENSe:AVERage ON`	Switches average function on.
Send → `READ:AC?`	Starts averaging AC-RMS.

Read ← `<AC-RMS voltage averaged over 16 sequential acquisitions from channel 1>`

Note: *For single-shot averaged acquisitions the trigger source must be one of the input channels <n> (INTernal<n>), instead of IMMediate (software automatic trigger).*

Front panel compliance:

The SENSe:AVERage[:STATe] command is the remote equivalent of the front panel AVERAGE key.

SENSe:AVERage:COUNt
SENSe:AVERage:TYPE?

Syntax: SENSe:AVERage:COUNt <NRf>

<NRf> 2 | 4 | 8 | 18 | ... | 2048 | 4096

SENSe:AVERage:TYPE?

Response: SCAL

Query form: SENSe:AVERage:COUNt? [MINinum | MAXimum]

Response: 2 | 4 | 8 | 16 | ... | 2048 | 4096

If MINimum was specified, 2 is returned.

If MAXimum was specified, 4096 is returned.

Description:

The SENS:AVER:COUN command sets the preprocessing average count factor. The count factor is a multiple of 2. The average value is calculated by the oscilloscope as follows:

$$AVG_n = \sum (X_1 + ... + X_n) / n$$

The SENS:AVER:TYPE? query returns the preprocessing average type used, which is the SCALar implementation.
If the oscilloscope is in the analog mode, error -221 "Settings conflict; Digital mode required" is generated.
After a *RST command, the average count factor is 8.

Example:

Send → `*RST`	Resets the instrument.
Send → `CONFigure:AC`	Configures for AC-RMS.
Send → `SENSe:AVERage:COUNt 16`	Average count factor becomes 16.
Send → `SENSe:AVERage ON`	Switches average function on.
Send → `INITiate`	Initiates trace averaging.
Send → `*WAI`	Waits for INITiate to finish.
Send → `TRACe? CH1`	Queries channel 1 trace.

Read ← `<channel 1 trace averaged over 16 sequential acquisitions>`

Front panel compliance:

The SENSe:AVERage:COUNt command is the remote equivalent of the front panel AVERAGE count option of the ACQUIRE menu.

SENSe:FUNCtion:OFF
SENSe:FUNCtion[:ON]
SENSe:FUNCtion:STATe?

Syntax: SENSe:FUNCtion:OFF "XTIMe:VOLTage<n>"
SENSe:FUNCtion:OFF "XTIMe:VOLTage:SUM <i,j>"
SENSe:FUNCtion[:ON] "XTIMe:VOLTege<n>"
SENSe:FUNCtion[:ON] "XTIMe:VOLTage:SUM <i,j>"

<n> [1] | 2 | 3 | 4

1 = CH1, 2 = CH2, 3 = CH3, 4 = CH4

Note: CH3 not applicable for PM33x0A.

<i,j> 1,2 | 3,4

1,2 CH1 + CH2

3,4 CH3 + CH4 (not for PM33x0A)

Query form: SENSe:FUNCtion:STATe? "XTIMe:VOLTage<n>"

Response: 0 | 1

0 Input channel <n> is off.

1 Input channel <n> is on.

Query form: SENSe:FUNCtion:STATe? "XTIMe:VOLTage:SUM <i,j>"

Response: 0 | 1

0 Addition of channel i+j is off.

1 Addition of channel i+j is on.

Description:

The SENSe:FUNCtion[:ON] command switches the input channel specified by <n> or the addition of two input channels specified by <i,j> ON.

The SENSe:FUNCtion:OFF commend switches the input channel specified by <n> or the addition of two input chennels specified by <i,j> OFF.

The SENSe:FUNCtion:STATe? query reports whether the specified input chennel <n> or the eddition of the input channels <i,j> is ON or OFF.

The parameters "XTIMe:VOLTage<n>" and "XTIMe:VOLTage:SUM <i,j>" are of the type <string_data> (specified between double or single quotes). Execution error -221 "Settings conflict" is genereted, if the execution of a command causes the last input chennel or the eddition of two input channels to be turned off.

In the analog mode, the added trace (e.g., CH1+CH2) as well es both channel traces (e.g., CH1, CH2) ere displeyed.

In the digital mode, the summarized trace (e.g., CH3+CH4) or the channel trace(s) (e.g., CH3, CH4) is displayed. Switching CH1+CH2 on, switches CH1 and CH2 off. Switching CH1+CH2 off, switches CH1 and CH2 on.

After a *RST command, channel 1 is switched on and the other channels are switched off. Also the addition of input channels is switched off.

Limitations:

For the PM33x0A CombiScope instruments:

- Channel 3 is not applicable and channel 4 is the external trigger view channel.
- Channel 4 can be switched on, only if it is already selected as trigger input (TRIGger:SOURce EXTernal).
- Channel 4 can be switched on, only if channel 1 or 2 is on.

Example:

`Send → *RST` Switches channel 1 on, and the others off.

`Send → SENSe:FUNCtion:ON 'XTIMe:VOLTage2'` Switches channel 2 on.

`The result is that the input channels 1 and 2 are switched on.`

`Send → SENSe:FUNCtion:ON 'XTIMe:VOLTage:SUM 1,2'` Switches CH1 + CH2 on.

`The result is that the addition of input channels 1 and 2 is switched on.`

Front panel compliance:

The SENSe:FUNCtion command is the remote equivalent of the front panel ON, CH1+CH2, and CH3+CH4 keys.

SENSe:SWEep:OFFSet:TIME

Syntax: SENSe:SWEep:OFFSet:TIME <NRf> I MINimum I MAXimum

<NRf> The trigger delay time in seconds. A negative value ceuses e pre-trigger view time, whereas e positive value ceuses a post-trigger deley time.

MINimum Selects the minimum possible pre-trigger view time.

MAXimum Selects the maximum possible post-trigger delay time.

Query form: SENSe:SWEep:OFFSet:TIME? [MINimum I MAXimum]

Response: <NR3>

<NR3> The trigger delay time in seconds.

If MINimum was specified, the minimum pre-trigger view time is returned.

If MAXimum was specified, the maximum post-trigger delay time is returned.

Description:

Controls the trigger delay time for the Main Time Base sweep.The trigger delay time may be positive (post-trigger) or negative (pre-trigger). The post-trigger delay time delays the data acquisition after a trigger. The pre-trigger view time allows for pre-trigger acquisition data. If the oscilloscope is in the analog mode, error -221 "Setting conflict;Digital mode required" is generated.
After a *RST command, the trigger delay is set at a pre-trigger view time of 5 milliseconds (5 divisions). Because the sweep time is set to 10 ms after a *RST, the trigger point is positioned in the middle of an acquisition.

Example:

Send → `*RST`	Resets the instrument.
Send → `SENSe:SWEep:TIME 5E-3`	The sweep_time becomes 5 ms; MTB = 0.5 ms/div.
Send → `SENSe:SWEep:OFFSet:TIME -0.001`	The pre-trigger view time becomes 1 ms (-2 div).
Send → `SENSe:SWEep:OFFSet:TIME 0.001`	The post-trigger delay time becomes 1 ms (+2 div).

Front panel compliance:

The SENSe:SWEep:OFFSet:TIME command is the remote equivalent of the front panel TRIGGER POSITION key.

SENSe:SWEep:PDETection[:STATe]

Syntax: SENSe:SWEep:PDETection[:STATe] <Boolean>

Query form: SENSe:SWEep:PDETection[:STATe]?

Response: 0 | 1

0 Peak detection switched off.

1 Peak detection switched on.

Description:

Switches peak detection on or off. If peak detection is switched on, the MTB range is limited to sequential sampling from 250 nanoseconds through 200 seconds per division (for MTB ranges, refer to the SENSe:SWEep:TIME command). For limitations on the peak detection speed (width of a glitch), refer to the function PEAK DETECTION of chapter 5 in the Operating Guide. In the analog mode, the error message -221 "Settings conflict;Digital mode required" is generated.
After a *RST command, peak detection is switched off.

Example:

Send → `CONFigure:PTPeak`	Configures for Peak-To-Peak.
Send → `INITIate:CONTinuous ON`	Sets Auto run mode.
Send → `DISPlay:MENU MEASure`	Displays MEASURE menu.
Send → `SYSTem:KEY 2`	Sets MEAS1 on.
Send → `SENSe:SWEep:PDETection on`	Sets peak detection on.
Send → `DISPlay:WINDow:TEXT1:DATA?`	Queries MEAS1 data.
Read ← `<pkpk,9438E-03,V>`	

Front panel compliance:

The SENSe:SWEep:PDETection command is the remote equivalent of the front panel ACQUIRE - PEAK DET on/off softkey menu.

SENSe:SWEep:REALtime[:STATe]

Syntax: SENSe:SWEep:REALtime[:STATe] <Boolean>

Query form: SENSe:SWEep:REALtime[:STATe]?

Response: 0 I 1

0 Real-time mode switched off.

1 Real-time mode switched on.

Description:

Switches the 'real- time' mode of the acquisition on or off. If the 'real-time' sampling mode is switched on, the MTB range is limited to sequential sampling from 250 nanoseconds through 200 seconds per division (for MTB ranges, refer to the SENSe:SWEep:TIME command). In the analog mode error -221 "Settings conflict;Digital mode required" is generated.
After a *RST command, the 'real-time' mode is switched off.

Example:

`Send → *RST`	Resets the instrument.
`Send → SENSe:SWEep:REALtime ON`	Sets real-time sampling on.
`Send → TRIGger:SOURce INTernal1;LEVel .1;SLOPe EITHer`	
Sets the following trigger settings:	source = internal channel 1 level = 0.1V slope = either pos. or neg.
`Send → INITiate`	Initiates a single acquisition.
`Send → READ:AC?`	Reads AC-RMS.
`Read ← <AC-RMS voltage>`	

Front panel compliance:

The SENSe:SWEep:REALtime command is the remote equivalent of the front panel REALTIME ONLY option of the TB MODE menu.

SENSe:SWEep:TIME

Syntax: SENSe:SWEep:TIME <NRf> | MINimum | MAXimum

<NRf> The sweep time in seconds.

MINimum Selects the minimum possible sweep time.

MAXimum Selects the meximum possible sweep time.

Query form: SENSe:SWEep:TIME? [MINimum | MAXimum]

Response: <NR3>

<NR3> The sweep time expressed in seconds.

If MINimum was specified, the minimum possible value is returned.

If MAXimum was specified, the maximum possible value is returned.

Description:

This command sets the time base of a sweep for all input channels in seconds. The time base of a sweep is the time duration of one complete trace acquisition. Together with the number of trace points (TRACe:POINts), the SENSe:SWEep:TIME command determines the Main Time Base (MTB). The MTB is expressed in seconds per division. Since there are 50 points in each division (horizontally), the MTB can be calculated from the following equation:

MTB = 50 * SENSe:SWEep:TIME / (TRACe:POINts - 1)

In the analog mode the main time base is put in the variable mode. In the digital mode the sweep times are limited by permitted MTB values according to the following table:

s	ms	µs	ns	
	500	500	500	
			250 ← not applicable for PM33x0A	
200	200	200	200	
100	100	100	100	
50	50	50	50	not valid
20	20	20	20	in the real
10	10	10	10	time mode
5	5	5	5	
2	2	2	2	
1	1	1		

Note: *If 2 or more channels are switched on in the real time mode, the time base range is limited to 10 µs (non-alternating time base).*

Table 4.2 MTB values in the digital mode

Limitations:

- The MTB value of 2 ns is not possible for the PM33x0A CombiScope instruments.
- If SENSe:SWEep:REALtime is ON, the MTB range is from 200 seconds to 250 nanoseconds, and sequential sampling is not guaranteed.

In a similar way, the time value Ts that is associated with a trace sample point can be calculated from the following expression:

Ts = <sample_index> * SENSe:SWEep:TIME / (TRACE:POINts - 1)

where <sample_index> is the point number of the sample in the trace.
After a *RST command, the sweep time is 10 milliseconds.

Coupled values:

There exists a coupling between programming of the sweep time and the number of trace points (acquisition length). The coupling is one way, which means that the sweep time changes if the acquisition length changes. Example:

- Send → *RST
  The number of trace points is 512.
- Send → SENSe:SWEep:TIME .04
  The sweep time is specified at 40 ms. The MTB becomes (0.04 * 50) / (511), which is rounded to 4 ms. The result of this is that the sweep time is changed to (0.004 * 511) / 50 = 0.04088 seconds.
- Send → TRACe:POINts CH1,4096
  The number of trace points becomes 4096 instead of 512. The result of this is that the sweep time becomes 8 times as high.

Note: *When the magnifying factor is *1, always 500 sample points (10 x 50) of the total acquisition length are visible on the display. So, if the acquisition length is 4096 samples, only 1/8 of the trace is displayed on the screen.*

Example:

```
Send → SENSe:SWEep:TIME?                     Requests sweep time
Read ← <sweep_time>                          Reads sweep time
Send → TRACe:POINts? CH1                     Requests nr of trace points
Read ← <acq_length>                          Reads number of trace points
MTB = 50 * <sweep_time> / (<acq_length> - 1) Calculates the MTB
PRINT "Main Time Base ="; MTB; "s/div"       Prints the MTB
```

Front panel compliance:

The SENSe:SWEep:TIME command is the remote equivalent of the front panel TB MODE "s VAR ns" keys.

SENSe:SWEep:TIME:AUTO

Syntax: SENSe:SWEep:TIME:AUTO <Boolean>

Query form: SENSe:SWEep:TIME:AUTO?

Response: 0 | 1

0 Autoranging MTB switched off.

1 Autoranging MTB switched on.

Description:

Switches the autoranging function of the Main Time Base (MTB) on or off. In the analog mode, the error message -221 "Settings conflict;Digital mode required" is generated. The MTB autoranging function is automatically switched off when the following occurs:

- A time base value is programmed (SENSe:SWEep:TIME).
- A channel is selected as trigger source (TRIGger:SOURce INTernal<n>), while channel<n> is off (SENSe:FUNCtion:STATe? returns 0).
- The Main Time Base (MTB) is switched off.

After a *RST command, autoranging MTB is switched off.

Example:

`Send → *RST`	Resets the instrument.
`Send → INITiate:CONTinuous ON`	Sets Auto run mode.
`Send → TRIGger:SOURce INTernal 1`	Sets trigger source CH1.
`Send → SENSe:SWEep:TIME:AUTO ON`	Sets autoranging MTB on.
`Send → SENSe:SWEep:TIME 0.5`	Sets sweep time at 500 ms and MTB becomes 50ms (autoranging off).

Front panel compliance:

The SENSe:SWEep:TIME:AUTO command is the remote equivalent of the front panel AUTO RANGE (MTB) key.

SENSe:VOLTage<n>[:DC]:RANGe:AUTO

Syntax: SENSe:VOLTage<n>[:DC]:RANGe:AUTO <Boolean>

<n> [1] | 2 | 3 | 4

Note: Channel 3 and 4 not applicable for PM33x0A.

Query form: SENSe:VOLTage<n>[:DC]:RANGe:AUTO?

Response: 0 | 1

0 Autoranging attenuator channel <n> switched off.

1 Autoranging attenuator channel <n> switched on.

Description:

Switches the autoranging function of channel <n> on or off. In the analog mode, the error message -221 "Settings conflict;Digital mode required" is generated. The autoranging attenuator function is automatically switched off when the following occurs:

- Attenuation value is programmed (SENSe:VOLTage<n>:RANGe:PTPeak).
- A channel is switched off (SENSe:FUNCtion:OFF "XTIMe:VOLTage<n>").
- The Main Time Base (MTB) is switched off.
- The applicable channel addition function, e.g., CH1+CH2, is switched on (SENSe:FUNCtion:ON "XTIMe:VOLTage:SUM 1,2").

After a *RST command, autoranging attenuation for all channels is switched off.

Note: Switching the autoranging attenuator on for a channel, automatically sets the input signal coupling for that channel to AC (INPut<n>:COUPling AC). Also the main timebase is switched from variable (VAR) into 1-2-5 step mode.

Example:

Send → `*RST`	Switches CH1 on.
Send → `SENSe:FUNCtion:ON 'XTIMe:VOLTage2'`	Switches CH2 on.
Send → `INITiate:CONTinuous ON`	Sets Auto run mode.
Send → `SENSe:VOLTage2:RANGe:AUTO ON`	Autoranging CH2.
Send → `SENSe:FUNCtion:ON 'XTIMe:VOLTage:SUM 1,2'`	Switches CH1 + CH2 on.

The result is that the addition of input channels 1 and 2 is switched on (CH1+CH2) and autoranging attenuator channel 2 switched off.

Front panel compliance:

The SENSe:VOLTage<n>:RANGe:AUTO command is the remote equivalent of the four front panel AUTO RANGE keys (one for each channel).

SENSe:VOLTage<n>[:DC]:RANGe:OFFSet

Syntax: SENSe:VOLTage<n>[:DC]:RANGe:OFFSet <NRf>
| MINimum | MAXimum

<n> [1] | 2 | 3 | 4

Note: Channel 3 and 4 not applicable for PM33x0A.

<NRf> The vertical offset for channel <n> in volts.

MINimum Selects the minimum possible vertical offset.

MAXimum Selects the maximum possible vertical offset.

Query form: SENSe:VOLTage<n>[:DC]:RANGe:OFFSet?
[MINimum | MAXimum]

Response: <NR3>

<NR3> The vertical offset for channel <n> in volts.

If MINimum was specified, the minimum possible value is returned.

If MAXimum was specified, the maximum possible value is returned.

Description:

Controls the vertical offset for an input channel. The vertical offset for channel <n> is expressed in volts. If a detectable probe is attached, the offset value is considered to be at the probe tip, otherwise at the BNC plug.
After a *RST command, the vertical offset for each channel is zero.

Coupled values:

The range of the offset value is directly coupled to the range of the vertical sensitivity per division (SENSe:VOLTage<n>:RANGe:PTPeak).

Example:

Send → `SENSe:VOLTage2:RANGe:OFFSet 1E-1`	Sets 100 mV offset for channel 2.

Front panel compliance:

The SENSe:VOLTage<n>:RANGe:OFFSet command is the remote equivalent of the front panel POS knobs.

SENSe:VOLTage<n>[:DC]:RANGe:PTPeak

Syntax: SENSe:VOLTage<n>[:DC]:RANGe:PTPeak <NRf>
| MINimum | MAXimum

<n> [1] | 2 | 3 | 4

Note: Channel 3 not applicable for PM33x0A.

<NRf> The vertical sensitivity for channel <n> in peak-to-peak volts, expressed in full scale (8 divisions).

MINimum Selects the minimum possible peak-to-peak value.

MAXimum Selects the maximum possible peak-to-peak value.

Query form: SENSe:VOLTage<n>[:DC]:RANGe:PTPeak?
[MINimum | MAXimum]

Response: <NR3>

<NR3> The vertical sensitivity for channel <n> in peak-to-peak Volt, expressed in full scale (8 divisions).

If MINimum was specified, the minimum possible value is returned.

If MAXimum was specified, the maximum possible value is returned.

Description:

Controls the vertical sensitivity for an input channel. The vertical sensitivity (expressed in full scale, 8 divisions) for channel <n> is set to a value of <ptpeak> volts. If a detectable probe is attached, the <ptpeak> value is considered to be at the probe tip; otherwise the value is at the BNC plug.

The number of points with which a trace is written on the screen depends on the resolution of the trace sample points (FORmat command). If the resolution is 8 bits, the number of points is 200 for the whole screen, which implies 200 / 8 = 25 points per division. If the resolution is 16 bits, the number of points is 200 * 256 = 51200 for the whole screen, which implies 51200 / 8 = 6400 points per division.

After a *RST command, the peak-to-peek value is reset es follows:

- For channel 1 to 1.6V: vertical sensitivity = 200 mV/div.
- For chennel 2 to 0.4V: vertical sensitivity = 50 mV/div.
- For PM3382A end PM3392A:
- For channel 3 end 4 to 4V: verticel sensitivity = 500 mV/div.

For PM3384A and PM3394A:

- For channel 3 and 4 to 8V: vertical sensitivity = 1 V/div.

For PM33x0A:

- For channel 4 to 8V: vertical sensitivity = 1 V/div.

Note: *If a 10:1 probe is connected to a channel, the peak-to-peak value is 10 times higher. For example, 80V instead of 8V.*

Coupled values:

There exists a coupling between programming of the attenuator (vertical sensitivity) and the trigger level. If the attenuator is changed, the trigger level is also adapted to keep the signal display on the screen. Programming tip:
First program the attenuator (SENSe:VOLTage:RANGe:PTPeak), and then the trigger level (TRIGger:LEVel).

Limitations:

For the PM3382A and PM3392A CombiScope instruments the peak-to-peak value of the input channels 3 and 4 can only be set to 0.8V and 4V (8 divisions). For the PM33x0A CombiScope instruments the peak-to-peak value of input channel 4 can only be set to 0.8V and 8V.

Example:

`Send → *RST`	Resets the instrument.
`Send → SENSe:VOLTage2:RANGe:PTPeak 0.8`	Peak-to-peak = 0.8V; sensitivity = 0.8 / 8 = 100 mV/div.
`Send → TRIGger:SOURce INTernal2;LEVel .2`	Trigger source = channel 2; level = 0.2V.
`Send → SENSe:FUNCtion "XTIMe:VOLTage2"`	Switches channel 2 ON.
`Send → INITiate:CONTinuous ON`	Initiates continuous acquisitions.

Front panel compliance:

The SENSe:VOLTage<n>:RANGe:PTPeek command is the remote equivalent of the front penel AMPL "mV VAR V" keys.

STATus:OPERation:CONDition?
STATus:OPERation:ENABle
STATus:OPERation[:EVENt]?
STATus:OPERation:NTRansition
STATus:OPERation:PTRansition

Syntax: STATus:OPERation:CONDition?
STATus:OPERation:ENABle <NRf>
STATus:OPERation[:EVENt]?
STATus:OPERation:NTRansition <NRf>
STATus:OPERation:PTRansition <NRf>

<NRf> Range from 0 to 32767.

Query form: STATus:OPERation:ENABle?
STATus:OPERation:NTRansition?
STATus:OPERation:PTRansition?

Response: <NR1>

Description:

The STATus:OPERation:CONDition? query reports the contents of the operation condition register. Reading a condition register has no effect on its contents. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.

The STATus:OPERation:ENABle command sets the contents of the operation event enable register. Setting a bit in the event enable register allows a true condition in the event register to be reported in the summary bit in the status byte register (STB). If a bit is 1 in the enable register and its associated event bit transition is true, a positive transition occurs in the operation summary bit. After power on, the enable mask is set to 0.

The STATus:OPERation? query reports and clears the contents of the operation event register. Reading an event register has the effect of clearing its contents. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set. After power on, the contents of the event register is cleared.

The STATus:OPERation:NTRansition command sets the contents of the negative transition filter of the operation register structure. The negative transition filter specifies which bits in the operation condition register, that make a negative transition (1 -> 0), set the corresponding bit in the operation event register.
For example, when you set bit 2 in this filter, it will set bit 2 in the operation event register at the time bit 2 in the operation condition register is reset (changed from 1 to 0). After power, on the contents of the negative transition filter is set to #H0000.

The STATus:OPERation:PTRansition command sets the contents of the positive transition filter of the operation register structure. The positive transition filter specifies which bits in the operation condition register, that make a positive transition (0 -> 1), set the corresponding bit in the operation event register. For example, when you set bit 2 in this filter, it will set bit 2 in the operation event register at the time bit 2 in the operation condition register is set (changed from 0 to 1). After power, on the contents of the negative transition filter is set to #H7FFF.

The bits have the following value and meaning:

BIT NUMBER	DECIMAL VALUE	MEANING:
0	1	CALibrating (performing a calibration).
2	4	RANGing (currently autoranging, autosetting).
3	8	SWEeping (busy with acquisition).
5	32	Waiting for TRIGger (INITiated).
8	256	Instrument is in the digital mode.
9	512	Pass/Fail status (bit 10) is valid.
10	1024	Pass/Fail status; 1 = test has failed.
other		-------- Not used. Zero is returned --------

Example:

Send → `STATus:OPERation:CONDition?`
Requests for operational condition.

Read ← `4`
The returned value 4 equals bit 2 set (instrument is currently autoranging).

Send → `STATus:OPERation:ENABle 4`
Enables report of bit 2 (RANGing) in operational event register.

Send → `STATus:OPERation:NTRansition 0`
Disables all bit reports from 1 to 0.

Send → `STATus:OPERation:PTRansition 4`
Enables report of "Autoranging started" (0 -> 1).

Send → `STATus:OPERation:EVENt?`
Requests for operational event.

Read ← 4
The returned value 4 equals bit 2 set (instrument has started autoranging).

Send → `STATus:OPERation:PTRansition 0`
Disables all bit reports from 0 to 1.

Send → `STATus:OPERation:NTRansition 4`
Enables report of "Autoranging stopped" (1 -> 0).

Send → `STATus:OPERation:EVENt?`
Requests for operational event.

Read ← `4`
The returned value 4 equals bit 2 set (instrument has stopped autoranging).

STATus:PRESet

Syntax: STATus:PRESet

Description:

The PRESet command is used to set the status data structure in such a way, that device-dependent events are reported at a higher level through the mandatory part of the status reporting mechanism. The PRESet command affects only the enable registers and the transition filters for the device-dependent status data structures. PRESet does not clear any of the event registers.

Note: Bit 15 of the 16-bit registers in the Status system is not used and remains zero. Bit 15 always returns zero when reading these registers.

The following table defines the effect of STATus:PRESet:

STATUS REGISTER	FILTER / ENABLE	PRESET VALUE
OPERation	ENABle	0000 hex.
	PTRansition	7FFF hex.
	NTRansition	0000 hex.
QUEStionable	ENABle	0000 hex.
	PTRansition	7FFF hex.
	NTRansition	0000 hex.

Example:

`Send → STATus:PRESet` Presets the status registers as indicated above.

STATus:QUEStionable:CONDition?
STATus:QUEStionable:ENABle
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:NTRansition
STATus:QUEStionable:PTRansition

Syntax: STATus:QUEStionable:CONDition?
STATus:QUEStionable:ENABle <NRf>
STATus:QUEStionable[:EVENt]?
STATus:QUEStionable:NTRansition <NRf>
STATus:QUEStionable:PTRansition <NRf>

<NRf> Range from 0 to 32767.

Query form: STATus:QUEStionable:ENABle?
STATus:QUEStionable:NTRansition?
STATus:QUEStionable:PTRansition?

Response: <NR1>

Description:

The STATus:QUEStionable:CONDition? query reports the contents of the questionable condition register. Reading a condition register has no effect on its contents. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.

The STATus:QUEStionable:ENABle command sets the contents of the questionable event enable register. Setting a bit in the event enable register allows a true condition in the event register to be reported in the summary bit in the status byte register (STB). If a bit is 1 in the enable register and its associated event bit transition is true, a positive transition occurs in the questionable summary bit. After power on, the enable mask is set to 0.

The STATus:QUEStionable? query reports and clears the contents of the questionable event register. Reading an event register has the effect of clearing its contents. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set. After power on, the contents of the event register is cleared.

The STATus:QUEStionable:NTRansition commend sets the contents of the negative transition filter of the questionable register structure. The negative trensition filter specifies which bits in the questionable condition register, thet make a negative trensition (1 -> 0), set the corresponding bit in the questioneble event register.
For example, when you set bit 2 in this filter, it will set bit 2 in the questionable event register et the time bit 2 in the questioneble condition register is reset (changed from 1 to 0). After power, on the contents of the negative transition filter is set to #H0000.

The STATus:QUEStionable:PTRansition command sets the contents of the positive transition filter of the questionable register structure. The positive transition filter specifies which bits in the questionable condition register, that make a positive transition (0 -> 1), set the corresponding bit in the questionable event register. For example, when you set bit 2 in this filter, it will set bit 2 in the questionable event register at the time bit 2 in the questionable condition register is set (changed from 0 to 1). After power, on the contents of the negative transition filter is set to #H7FFF.

The bits have the following value and meaning:

BIT NUMBER	DECIMAL VALUE	MEANING:
0	1	Digital sample value is clipped at max. or min. during VOLTage calculation.
4	16	TEMPerature too high or too low.
8	256	Calibration is not successfully completed.
9	512	A 50Ω input terminator is overloaded.
14	16384	Unexpected parameter in measurement instruction.
other		--------- Not used. Zero is returned ----------

Example:

Send → `STATus:QUEStionable:CONDition?`
Requests for questionable condition.

Read ← `16`
The returned value 16 equals bit 4 set (temperature too high/low).

SendÆ `STATus:QUEStionable:ENABle 16`
Enables report of bit 4 (TEMPerature) in questionable event register.

Send → `STATus:QUEStionable:NTRansition 0`
Disables all bit reports from 1 to 0.

Send → `STATus:QUEStionable:PTRansition 16`
Enables report of "TEMPerature too high/low" (0 -> 1).

Send → `STATus:QUEStionable:EVENt?`
Requests for questionable event.

Read ← `16`
The returned value 16 equals bit 4 set (temperature too high/low).

Send → `STATus:QUEStionable:PTRansition 0`
Disables all bit reports from 0 to 1.

Send → `STATus:QUEStionable:NTRansition 16`
Enables report of "TEMPerature within allowed limits" (1 -> 0).

Send → `STATus:QUEStionable:EVENt?`
Requests for questionable event.

Read ← `16`
The returned value 16 equals bit 4 set (TEMPerature okay).

STATus:QUEue[:NEXT]?

Syntax: STATus:QUEue[:NEXT]?

Response: <error_number>,"<error_description>"

<error_number>	A predefined number. If 0 (zero) is returned, there are no errors in the queue.
<error_description>	A short description of the error. When there are no errors in the queue, the description is "No error".

Description:

The STATus:QUEue? query reports the next event from the error/event queue and removes this event from the queue. The error queue is a "First-In First-Out" (FIFO) queue. Therefore, the error query returns the oldest error. Once an error is read, it is removed from the queue and the next error message is made available. STATus:QUEue? is the alias of the SYSTem:ERRor? query. If the queue is empty, the instrument responds with:

0,"No error"

The error/event queue has space for 20 messages. If there are more messages than the queue can hold, it will overflow. The oldest messages stay in the queue, but the most recent message is discarded and the latest message is written in its place. When the event/error queue overflows, the last position in the queue is set to:

-350,"Queue overflow"

The error/event queue is cleared:

- After power on.
- When *CLS is received.
- When the last error in the queue is read.

Example:

Send → `STATus:QUEue?`
Read ← `-222,"Data out of range"`
The error number is -222 and the meaning is "Data out of range".

SYSTem:BEEPer
SYSTem:BEEPer:STATe

Syntax: SYSTem:BEEPer

SYSTem:BEEPer:STATe <Boolean>

Query form: SYSTem:BEEPer:STATe?

Response: 0 | 1

0 Beeper disabled.

1 Beeper enabled.

Description:

The SYST:BEEP command causes a beep of about 1 second to be generated by the instrument, even if the SYSTem:BEEPer:STATe is OFF.
The SYST:BEEP:STAT command enables or disables the beeper of the instrument. If the STATe is turned OFF, no instrument condition will cause an audible beep to be emitted.
After a *RST command, the beeper is turned on.

Example:

```
Send → SYSTem:ERRor?                      Reads the error queue.
Read ← error_number,"error_description"
IF error_number = 0 THEN
   send → SYSTem:BEEPer                   Beeps on error.
END IF
Send → SYSTem:BEEPer:STATe OFF            Turns automatic beeper off.
Send → SYSTem:BEEPer                      Generates a beep.
```

Front panel compliance:

The SYSTem:BEEPer:STATe command is the remote equivalent of the front panel BEEP ON OFF option of the UTILITY menu.

SYSTem:COMMunicate:SERial:CONTrol:DTR
SYSTem:COMMunicate:SERial:CONTrol:RTS

Syntax: SYSTem:COMMunicate:SERial:CONTrol:DTR ON | STANdard
SYSTem:COMMunicate:SERial:CONTrol:RTS ON | STANdard

ON	Selects the "3 wire" option. The DTR or RTS line is always asserted.
STANdard	Selects the "7 wire" option.

Query form: SYSTem:COMMunicate:SERial:CONTrol:DTR?
SYSTem:COMMunicate:SERial:CONTrol:RTS?

Response: ON | STAN

ON	"3 wire" DTR/RTS control.
STAN	"7 wire" DTR/RTS control.

Description:

Controls the DTR (Data Terminal Ready) or RTS (Request To Send) line of the EIA-232-D (RS-232-C) interface. This command has the same effect as selecting "3 wire" or "7 wire" via front panel control. The RTS (Request To Send) line control is coupled to the DTR (Data Terminal Ready) line control.
After a *RST command, the DTR/RTS control remains unchanged.
After power on, the oscilloscope is in its local state (controlled via front panel).

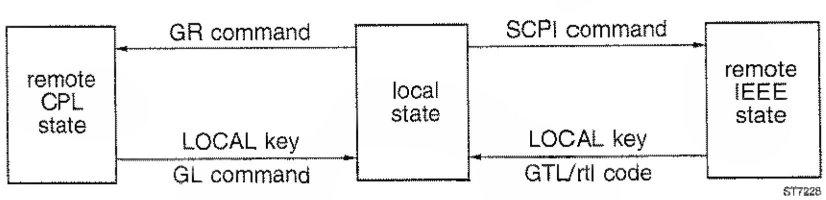


Figure 4.1 Local/remote control

Example:

Send → `SYSTem:COMMunicate:SERial:CONTrol:DTR ON`	Selects the "3 wire" control.

Front panel compliance:

The SYSTem:COMMunicate:SERial:CONTrol command is the remote equivalent of the front panel REMOTE SETUP - RS232 SETUP option of the UTILITY menu.

SYSTem:COMMunicate:SERial[:RECeive]:BAUD
SYSTem:COMMunicate:SERial:TRANsmit:BAUD
SYSTem:COMMunicate:SERial[:RECeive]:BITS
SYSTem:COMMunicate:SERial:TRANsmit:BITS
SYSTem:COMMunicate:SERial[:RECeive]:PACE
SYSTem:COMMunicate:SERial:TRANsmit:PACE
SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE]
SYSTem:COMMunicate:SERial:TRANsmit:PARity[:TYPE]

Syntax: SYSTem:COMMunicate:SERial[:RECeive]:BAUD <baudrate>
SYSTem:COMMunicate:SERial:TRANsmit:BAUD <baudrate>

<baudrate> 75 | 110 | 150 | 300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | MIN | MAX

SYSTem:COMMunicate:SERial[:RECeive]:BITS 7 | 8
SYSTem:COMMunicate:SERial:TRANsmit:BITS 7 | 8

SYSTem:COMMunicate:SERial[:RECeive]:PACE XON | NONE
SYSTem:COMMunicate:SERial:TRANsmit:PACE XON | NONE

XON Enables the X-on/X-off handshake.

NONE Disables the X-on/X-off handshake.

SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE] EVEN | ODD | NONE
SYSTem:COMMunicate:SERial:TRANsmit:PARity[:TYPE] EVEN | ODD | NONE

Query form: SYSTem:COMMunicate:SERial[:RECeive]:BAUD? [MIN | MAX]
SYSTem:COMMunicate:SERial:TRANsmit:BAUD? [MIN | MAX]

Response: 75 | 110 | 150 | 300 | 600 | 1200 | 2400 | 4800 | 9600 | 19200 | 38400

If MINimum was specified, 75 is returned.

If MAXimum was specified, 38400 is returned.

Query form: SYSTem:COMMunicate:SERial[:RECeive]:BITS?
SYSTem:COMMunicate:SERial:TRANsmit:BITS?

Response: 7 | 8

Query form: SYSTem:COMMunicate:SERial[:RECeive]:PACE?
SYSTem:COMMunicate:SERiel:TRANsmit:PACE?

Responso: XON | NONE

XON	X-on/X-off handshake enabled.
NONE	No X-on/X-off handshaking.

Query form: SYSTem:COMMunicate:SERial[:RECeive]:PARity[:TYPE]?
SYSTem:COMMunicate:SERial:TRANsmit:PARity[:TYPE]?

Response: EVEN | ODD | NONE

Description:

BAUD sets the baudrate of the EIA-232-D (RS-232-C) interface for both the receive and transmit channel.
BITS sets the number of data bits of the EIA-232-D (RS-232-C) interface for both the receive and transmit channel. Instead of 7, MINimum can be specified. Instead of 8, MAXimum can be specified. The number of stop bits is always one. If 7 data bits are specified and the parity type is NONE, an execution error is reported.
PACE sets pacing (XON-XOFF) or no pacing at all (NONE) of the EIA-232-D (RS 232-C) interface for both the receive and transmit channel.
PARity sets the parity type of the EIA-232-D (RS-232-C) interface for both the receive and transmit channel. The parity type can be even (EVEN), odd (ODD), or no parity at all (NONE). If the type of parity is NONE and the number of data bits is 7, an execution error is reported.
After a *RST command, the interface settings remain unchanged.

Example:

`Send → SYSTem:COMMunicate:SERial:BAUD 1200`	Baudrate becomes 1200.
`Send → SYSTem:COMMunicate:SERial:BITS 8`	Number of data bits becomes 8.
`Send → SYSTem:COMMunicate:SERial:PACE XON`	XON becomes true.
`Send → SYSTem:COMMunicate:SERial:PARity EVEN`	Parity type becomes EVEN.

Front panel compliance:

The SYSTem:COMMunicete:SERial commands ere the remote equivalent of the front panel REMOTE SETUP - RS232 SETUP option of the UTILITY menu.

SYSTem:DATE

Syntax: SYSTem:DATE <year>,<month>,<day>

<year>	<NRf> I MINimum I MAXimum Range from 1992 to 2091.
<month>	<NRf> I MINimum I MAXimum Range from 1 to 12.
<day>	<NRf> I MINimum I MAXimum Range from 1 to 31.

Query form: SYSTem:DATE? [MINimum I MAXimum , MINimum I MAXimum, MINimum I MAXimum]

Response: <year>,<month>,<day>

The date values returned are of type <NR1>. If MINimum was specified, the lowest possible value is returned. If MAXimum was specified, the highest possible value is returned.

Description:

The SYSTem:DATE command programs the date of the instrument by specifying the year, month, and day. The date values are rounded to the nearest integer value. The <year> parameter consists of a four-digit number, e.g., 1994. The current date is not changed after a *RST command.

Example:

Send → `SYSTem:DATE 1994,4,5`	Sets the system date to April 5, 1994.
Send → `SYSTem:DATE? MAX,MAX,MAX`	Queries for the max. values possible.
Read ← `2091,12,31`	Reads December 31 of the year 2091.

Front panel compliance:

The SYSTem:DATE command is the remote equivalent of the UTILITY - CLOCK - yy:mm:dd softkey menu.

SYSTem:ERRor?

Syntax: SYSTem:ERRor?

Response: <error_number>,"<error_description>"

<error_number>	A predefined number. If 0 (zero) is returned, there are no errors in the queue.
<error_description>	A short description of the error. When there are no errors in the queue, the description is "No error".

Description:

The SYSTem:ERRor? query reports the next event from the error/event queue and removes this event from the queue. The error queue is a "First-In First-Out" (FIFO) queue. Therefore, the error query returns the oldest error. Once an error is read, it is removed from the queue and the next error message is made available. SYSTem:ERRor? is the alias of the STATus:OUEue? query. If the queue is empty, the instrument responds with:

0,"No error"

The error/event queue has space for 20 messages. If there are more messages than the queue can hold, it will overflow. The oldest messages stay in the queue, but the most recent message is discarded and the latest message is written in its place. When the event/error queue overflows, the last position in the queue is set to:

-350,"Queue overflow"

The error/event queue is cleared:
- After power on.
- When *CLS is received.
- When the last error in the queue is read.

Example:

```
Send → SYSTem:ERRor?
Read ← -222,"Data out of range"
```

The error number is -222 and the meaning is "Data out of range".

SYSTem:KEY

Syntax: SYSTem:KEY <NRf> | MINimum | MAXimum

<NRf> Reference number to a key:

1, 2, 3, 4, 5, 6:	softkey-1 (top) to softkey-6 (bottom)
101, 102, 103, etc.:	top row of keys (left to right)
• • • •	
• • • •	
801, 802, 803, etc.:	bottom row of keys (left to right)

MINimum Specifies the smallest key number.

MAXimum Specifies the largest key number.

Query form: SYSTem:KEY? [MINimum | MAXimum]

Response: <NR1>

<NR1> Reference number of the last key for which pressing was simulated.

If MINimum was specified, the minimum possible key number is returned.

If MAXimum was specified, the maximum possible key number is returned.

Description:

The SYSTem:KEY command simulates the action of pressing a front panel key, specified by the rounded integer value of the key number.
The SYSTem:KEY? query returns the key number corresponding to the last key that was pressed. A value of -1 indicates that no key was pressed since power on or after a *RST command. If the URQ (user request) bit in the standard Event Status Register (ESR) is set, a key on the front panel has been pressed. This URQ bit can be used to signal the event of pressing a key on the front panel to the controller.

Note: *With this command the pressing of one key at the same time is simulated. A combination, e.g., STATUS + TEXT OFF at the same time, cannot be simulated. The command execution is finished directly. However, the actions that take place in the instrument as a result of a SYSTem:KEY command, can last longer. A SYSTem:KEY command cannot be synchronized by sending a *WAI or *OPC? immediately thereafter.*

*Example: SYSTem:KEY 101;*WAI continues program execution immediately (*WAI ignored), although the AUTOSET (= key 101) still continues for a few seconds.*

FRONT PANEL KEY	<NR1>	FRONT PANEL KEY		<NR1>	EXCEPTIONS
Softkey 1 (top)	1	VERT MENU		504	
Softkey 2	2	AVERAGE		507	
Softkey 3	3	TRIG 1		604	
Softkey 4	4	TRIG 2		607	
Softkey 5	5	TRIG 3		610	
Softkey 6 (bottom)	6	TRIG 4		613	EXT TRIG for PM33x0A
AUTOSET	101				
CAL (no effect)	102				
SETUPS	103	AMPL mv (▲)	CH1	702	
UTILITY	104	AUTO RANGE	CH1	703	
ANALOG	106	CH1 + CH2		704	
ACQUIRE	107	AMPL mv (▲)	CH2	705	
SAVE	108	AUTO RANGE	CH2	706	
RECALL	109	INV	CH2	707	
MEASURE	110	AMPL mv (▲)	CH3	708	only for PM3384A-94A
MATH	111	AUTO RANGE	CH3	709	AMPL for PM3382A-92A and PM33x0A
DISPLAY	112	CH3 + CH4		710	
HARD COPY	113	AMPL mv (▲)	CH4	711	only for PM3384A-94A
		AUTO RANGE	CH4	712	AMPL for PM3382A-92A
STATUS (LOCAL)	201				
CURSORS	204	INV	CH4	713	
TRIGGER	209				
MAGNIFY (◄)	210	TEXT OFF		801	
MAGNIFY (►)	211	AMPL v (▼)	CH1	802	
		ON	CH1	803	
RUN/STOP	309	AC/DC/GND	CH1	804	
AUTO RANGE	310	AMPL v (▼)	CH2	805	
SINGLE_ARMED	311	ON	CH2	806	
		AC/DC/GND	CH2	807	
DTB	402	AMPL v (▼)	CH3	808	only for PM3384A-94A
DTB TIME/DIV s (◄)	403	ON	CH3	809	
DTB TIME/DIV ns (►)	404	AC/DC/GND	CH3	810	AC/DC for PM3382A-92A
TB MODE	409	AMPL v (▼)	CH4	811	only for PM3384A-94A
TIME/DIV VAR s (◄)	410	ON	CH4	812	TRIG VIEW for PM33x0A
TIME/DIV VAR ns (►)	411	AC/DC/GND	CH4	813	AC/DC for PM3382A-92A and PM33x0A

Table 4.3 Reference number for front panel keys

Notes:
- *Simulation of pressing the CAL key (102) is not useful, because calibration is only done when pressed for 2 seconds.*
- *Simulation of pressing the HARD COPY key (113) is only useful, when the RS-232-C interface is selected as output connection.*
- *Channel 3 (CH3) not applicable for PM33x0A.*

Example 1:

Send → `SYSTem:KEY 101`	Simulates the pressing of AUTOSET.
Send → `SYSTem:KEY?`	
Read ← `101`	Returns the last key simulation.

Example 2:

Send → `*RST`	Resets the instrument.
Send → `DISPlay:MENU UTIL`	Enables UTILITY softkey menu.
Send → `SYSTem:KEY 2;KEY 5;KEY 4`	Selects the options PROBE, PROBE CORR, 10:1.
Send → `DISPlay:MENU:STATe OFF`	Disables UTILITY softkey menu.

In this example the probe correction factor for input channel 1 is set at 10:1, using the softkey menu UTILITY.

Front panel compliance:

The SYSTem:KEY command is the remote equivalent of pressing all front panel keys.

SYSTem:SET

Syntax: SYSTem:SET <indefinite_block>

Query form: SYSTem:SET? [<node_nr> | MINimum | MAXimum]

<node_nr> A number specifying which node settings. The following nodes are supported:

0 End node indicator.
1|2|3|4 Channel 1 (MINimum) / 2 / 3 / 4 settings
14 Probe scale settings
15 Common vertical settings
16 Horizontal settings
17 Main timebase settings
18 Delayed time base settings
19 Event trigger delay settings
20 SCPI trigger source
32 Cursor settings
33 Cursor autosearch settings
49|50 MEASurement 1/2 settings
51 Pass/Fail test settings
65|66 MATH1/2 settings
80 Display settings
81 Trace intensity settings
82 Display trace position settings
96 Setup label text
112 Autorange settings
128 Real-time clock settings
240 Service (factory) settings (MAXimum)

Response: <indefinite_block>

Description:

The SYSTem:SET command programs the instrument to a complete or partial instrument setup (defined by a node number) using the instrument settings that were previously retrieved with the SYSTem:SET? query. The instrument settings are binary settings (bits and bytes) that are changing dynamically. In addition, various settings are interdependent, even settings divided across different nodes. For these reasons, instrument settings must not be changed individually. Appendix E summarizes which instrument settings belong to which node.

If the <node_nr> doesn't exist, the error message -222,"Data out of range; reserved for future use" is generated. If the <node_nr> is not applicable for this instrument, the error message -222,"Data out of range; reserved for combi instrument" is generated.

Limitations:

For the PM33x0A CombiScope Instruments:
- Input channel 3 (CH3) is not applicable.
- Input channel 4 (CH4) is limited to external trigger view.

Example:

Send → `SYSTem:SET? 32`	Queries for cursor instrument settings.
Read ← `<curs_setup>`	Reads cursor instrument settings.
Send → `SYSTem:SET?`	Queries for all instrument settings.
Read ← `<settings>`	Reads all instrument settings.
Send → `SYSTem:SETSP`	Sends the header plus a space without message termination (EOI off).
Send → `<settings>`	Sends all instrument settings, plus message termination (EOI on).

Programming tip:

The number of <settings> bytes can be determined from the second byte of the returned <settings> information itself. A node is always built up as follows:

<node_nr> <node_length> <first_byte> ... <last_byte>

The second <node_length> byte indicates the number of bytes to follow.
If no <node_nr> was specified the number of bytes must be determined while reading the <settings>.

Front panel compliance:

The SYSTem:SET? query followed by the SYSTem:SET command gives a remote possibility to save and recall complete or partial instrument setups.

SYSTem:TIME

Syntax: SYSTem:TIME <hour>,<minute>,<second>

<hour>	<NRf> I MINimum I MAXimum Range from 0 to 23.
<minute>	<NRf> I MINimum I MAXimum Range from 0 to 59.
<second>	<NRf> I MINimum I MAXimum Range from 0 to 59.

Query form: SYSTem:TIME? [MINimum I MAXimum , MINimum I MAXimum , MINimum I MAXimum]

Response: <hour>,<minute>,<second>

The time values returned are of type <NR1>. If MINimum was specified, the lowest possible value is returned. If MAXimum was specified, the highest possible value is returned.

Description:

The SYSTem:TIME command programs the real-time clock of the instrument by specifying the hour, minute, and second. Only a 24-hours time format is supported. The current time is not changed after a *RST command.

Example:

Send → `SYSTem:TIME 11,22,33`	Sets the system time to 11 hours + 22 minutes + 33 seconds, i.e.: 11:22:33.
Send → `SYSTem:TIME? MAX,MAX,MAX`	Oueries for the max. values possible.
Read ← `23,59,59`	Reads 23 hours, 59 minutes, 59 seconds.

Front panel compliance:

The SYSTem:TIME command is the remote equivalent of the UTILITY - CLOCK - hh:mm:ss softkey menu.

SYSTem:VERSion?

Syntax: SYSTem:VERSion?

Response: YYYY.V

YYYY	The year number of the SCPI version.
V	The approved revision number within the year.

Description:

Reports the version of the SCPI command set to which your instrument complies. The year and revision number within that year is returned, e.g., 1992.0. The *RST command doesn't change the current SCPI version.

Example:

```
Send → SYSTem:VERSion?
Read ← 1992.0
```

TRACe:COPY

Syntax: TRACe:COPY <destination_trace>,<source_trace>

Alias: DATA:COPY <destination_trace>,<source_trace>

<source_trace>	CHn I Mi_n
<destination_trace>	Mi_n

n = 1 .. 4
i = 1 .. 8 (standard memory)
i = 1 .. 50 (extended memory)

Description:

Copies a trace from one trace memory (source) to another (destination). The contents of the <source_trace> is copied to the <destination_trace>. The trace administration data is copied as well. If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.

Note: *If the <source> trace is being built, the copy action takes place after completion of the source trace.*

Limitations:

For the PM33x0A CombiScope instruments:
- CH3 and Mi_3 is not applicable.
- CH4 is the external trigger view channel, so:
  - EXTernal is the alias for CH4.
  - Mi_E is the alias for Mi_4.

Example:

Send → *RST	Resets the instrument.
Send → SENSe:FUNCtion "XTIMe:VOLTage2"	Switches channel 2 on.
Send → TRACe:COPY M1_1,CH1	The result is that the trace memories of channel 1 and 2 copied to M1_1 and M1_2 respectively.

Front panel compliance:

The TRACe:COPY command is the remote equivalent of the front panel COPY option of the **SAVE** menu.

TRACe[:DATA]

Syntax: TRACe[:DATA] <destination_trace> , <NRf> I <definite_block>

Alias: DATA[:DATA] <destination_trace> , <NRf> I <definite_block>

<destination_trace> Mi_n

n = 1 .. 4
i = 1 .. 8 (standard memory)
i = 1 .. 50 (extended memory)

<NRf> Constant value:

- Range from -128 to +127 (1 byte trace points).
- Range from -32768 to +32767 (2 byte trace points).

<definite_block> The format of the block data is as follows:

```
# n x . . x f b . . . . . b s <NL>
| |____|  | |_______|   | |___|
|   |     |     |       |   |____ NewLine code
|   |     |     |       |________ checksum over all trace bytes
|   |     |     |________________ trace sample data bytes
|   |     |______________________ trace data format byte
|   |____________________________ number of trace bytes (fbb...bbs)
|________________________________ number of digits of x..x
```

Notes:

- *If f=8 decimal, each trace sample is one byte (8 bits).*
- *If f=16 decimal, each trace sample is two bytes (16 bits), i.e., most significant byte (msb) + least significant byte (lsb).*
- *The checksum is done over all trace sample data bytes by adding the bytes one by one as follows: SUM = (SUM + byte N)MOD256*

Query form: TRACe[:DATA]? <source_trace>

<source_trace> CHn I Mi_n

n = 1 .. 4
i = 1 .. 8 (standard memory)
i = 1 .. 50 (extended memory)

Response: <definite_block>

Limitations:

For the PM33x0A CombiScope instruments:

- CH3 and Mi_3 is not applicable.
- CH4 is the external trigger view channel, so:
  - EXTernal is the alias for CH4.
  - Mi_E is the alias for Mi_4.

Description:

The TRACe? query reads a binary trace block from channel acquisition memory (CH1 to CH4) or from register memory (M1 to M8 for standard memory and M9 to M50 for extended memory). The TRACe command writes a binary trace block to register memory (M1 to M8 for standard memory and M9 to M50 for extended memory).

A specified constant can also be written into trace register memory. If a constant is specified, the rounded signed constant value is copied to all trace points in the register memory.

Trace data can only be read when the trace memory is not empty. The internal trace administration data is not affected. If the length of the trace block doesn't match the length of the destination register, the following happens:

- If the destination register is longer, the remainder of the destination register is not affected.
- If the destination register is shorter, the remainder of the trace block is ignored.

In both cases no error is reported.
If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.

Note: *If the queried trace is being built, the query action will take place after completion of the building process. To cancel running acquisitions, use the ABORt command.*

As an example the format of the block data of a trace of 512 "16-bit" samples is shown:

trace bytes

4 1 0 2 6 <16> <msb 1> <lsb 1> . . . <msb 512> <lsb 512> <checksum> <NL>

trace sample 512
trace sample 1
byte with decimal value 16
number of trace bytes (1026)
number of digits of 1026

Example 1:

In this program example a trace is read from the actual signal at input channel 1. The received data block is converted to an array of voltages. This program example works for traces of 512 samples, consisting of 8 bits (1 byte) or 16 bits (2 bytes) samples.

`Send → *RST`	Resets the instrument.
`Send → CONFigure:AC (@1)`	Configures for AC-RMS.
`Send → INITiate`	Initiates single acquisition.

```
Send → *WAI                             Waits for end of acquisition.
Send → TRACe? CH1                       Requests channel 1 trace.
Read ← <block_data>                     Reads channel 1 trace.
Determine nr.of.samples from <block_data>.

Send → SENSe:VOLTage:RANGe:PTPeak?      Queries peak-to-peak.
Read ← <peak-to-peak>                   Reads peak-to-peak.
Send → SENSe:VOLTage:RANGe:OFFSet?      Queries offset.
Read ← <offset>                         Reads offset.

IF (sample is 1 byte) THEN
 FOR i = 1 TO nr.of.samples
  Determine trace(i) value from <block_data>.
  IF trace(i) > 127 THEN trace(i) = trace(i) - 256
  sample(i) = trace(i) / 200 * <peak-to-peak> - <offset>
 NEXT i
ELSE (sample is 2 bytes)
 FOR i = 1 TO nr.of.samples
  Determine msb of trace(i) value from <block_data>.
  Determine lsb of trace(i) value from <block_data>.
  IF msb < 128 THEN trace(i) = msb * 256 + lsb
  ELSE trace(i) = (msb - 256) * 256 + lsb
  sample(i) = trace(i) / 51200 * <peak-to-peak> - <offset>
 NEXT i
END IF
```

Note: *For an explanation plus a program example about "Conversion of trace data", refer to section 3.4.3.*

Example 2:

`Send → FORMat INTeger,8`	Number of trace point bits becomes 8.
`Send → TRACe M1_2,5`	All trace points of trace 2 of memory register 1 are set to the value 00000101 (bit value = 4 + 1).
`Send → FORMat INTeger,16`	Number of trace point bits becomes 16.
`Send → TRACe M2_3,1025`	All trace points of trace 3 of memory register 2 are set to the value 0000010000000001 (bit value = 1024 + 1).

Front panel compliance:

The TRACe command is the remote equivalent of the front panel SAVE ACQ TO MEMORY option of the SAVE menu. The TRACe? query is the remote equivalent of the front panel RECALL REGISTER MEMORY option of the SAVE menu.

TRACe:POINts

Syntax: TRACe:POINts <source_trace> [,<acquisition_length>]

Alias: DATA:POINts <source_trace> [,<acquisition_length>]

<source_trace>	CHn I Mi_n n = 1 .. 4 i = 1 .. 8 (standard memory) i = 1 .. 50 (extended memory)
<acquisition_length>	<NRf> I MINimum I MAXimum
<NRf>	512 I 2048 I 4096 I 8192 (standard memory) 512 I 8192 I 16384 I 32768 (extended memory) *Notes:* - *512 is the default value.* - *8192 (standard) and 32768 (extended) not applicable for PM33x0A.*
MINimum	Length becomes 512 points.
MAXimum	Length becomes 8192, if no extended memory is available. Length becomes 32768, if extended memory is available.

Query form: TRACe:POINts? <source_trace> [,MINimum I MAXimum]

<source_trace>	CHn I Mi_n n = 1 .. 4 i = 1 .. 8 (standard memory) i = 1 .. 50 (extended memory)

If MINimum was specified, the minimum possible trace length is returned.

If MAXimum was specified, the maximum possible trace length is returned.

Response: <acquisition_length>

Description:

Defines the trace length (number of trace points) for all traces. The acquisition length and the length of all internal traces is programmed to the value specified in <acquisition_length>. If the <acquisition_length) parameter is omitted, the default value of 512 is assumed. If the oscilloscope is in the analog mode, error -221 "Settings conflict;Digital mode required" is generated.

Limitations:

For the PM33x0A CombiScope instruments:
- CH3 and Mi_3 is not applicable.
- CH4 is the external trigger view channel, so:
  - EXTernal is the alias for CH4.
  - Mi_E is the alias for Mi_4.

Coupled values:

There exists a coupling between programming of the sweep time and the number of trace points (acquisition length). The coupling is one way, i.e., the sweep time changes if the acquisition length changes.
Example:

The number of trace points is 2048.
- Send → SENSe:SWEep:TIME .04

The sweep time becomes 40.9 ms.
- Send → TRACe:POINts M1_1,4096

The number of trace points becomes 4096.
- Send → SENSe:SWEep:TIME?

The response is 819E-04, which means that the sweep time was doubled to 81.9 milliseconds.

CAUTION: **If the acquisition length is programmed to a different value, all acquisition and register trace memories are cleared. So, all previously defined traces are lost!**

Example:

Send → `TRACe:POINts CH1,8192`	Number of trace points for all trace memories becomes 8192.
Send → `TRACe? M2_3`	Requests M2_3 trace.
Read ← `<block_data>`	Reads M2_3 trace.

Front panel compliance:

The TRACe:POINts command is the remote equivalent of the front panel ACQ LENGTH option of the TB MODE menu.

TRIGger[:SEQuence[1]]:FILTer:HPASs:FREQuency
TRIGger[:STARt]:FILTer:HPASs:FREQuency
TRIGger[:SEQuence[1]]:FILTer:HPASs:STATe
TRIGger[:STARt]:FILTer:HPASs:STATe

Syntax: TRIGger[:SEQuence[1]]:FILTer:HPASs:FREQuency <NRf> | MINimum | MAXimum

TRIGger[:SEQuence[1]]:FILTer:HPASs:STATe <Boolean>

Alias: TRIGger[:STARt]:FILTer:HPASs:FREQuency <NRf> | MINimum | MAXimum

TRIGger[:STARt]:FILTer:HPASs:STATe <Boolean>

<NRf> The cutoff frequency expressed in hertz. The only possible value is 30000, which defines HF-reject (LF-pass).

<Boolean> 0 | OFF Sets high-pass filter off.
1 | ON Sets high-pass filter on.

Query form: TRIGger[:SEQuence[1]]:FILTer:HPASs:FREQuency? MINimum | MAXimum

Alias: TRIGger[:STARt]:FILTer:HPASs:FREQuency? MINimum | MAXimum

Response: 3.00E+04 | 1.00E+08 | 2.00E+08

3.00E+04 Fixed cutoff frequency of 30 KHz (MINimum).

1.00E+08 Bandwidth of 100 MHz (MAXimum for PM338xA).

2.00E+08 Bandwidth of 200 MHz (MAXimum for PM339xA).

Query form: TRIGger[:SEQuence[1]]:FILTer:HPASs:STATe?

Alias: TRIGger[:SEQuence[1]]:FILTer:HPASs:STATe?

Response: 0 | 1

0 Low-pass filter active.

1 High-pass filter active (HF-reject).

Description:

The TRIGger:FILTer:HPASs:FREQuency command sets the MTB cutoff frequency always at the fixed value of 30000 Hz (all values are rounded to 30 KHz).

The TRIGger:FILTer:HPASs:STATe command activates (ON) or deactivates (OFF) the MTB high-pass filter.

Activating the MTB high-pass filter:
- automatically deactivates the MTB low-pass filter.
- sets the high-pass cutoff frequency at 30 KHz (HF-reject).
- sets the low-pass cutoff frequency at 0 Hz.

DeActivating the MTB low-pass filter:
- automatically activates the MTB low-pass filter.
- sets the high-pass cutoff frequency at bandwidth (100/200 MHz).
- sets the low-pass cutoff frequency at 0 Hz (DC coupling).

After a *RST command, the high-pass filter is OFF.

Note: The following coupling exists between programming the cutoff frequency and (de)-activating the low-pass or high-pass filter:

	FILTER	
FREOUENCY	LOW-PASS ON	HIGH-PASS ON
0 Hz	DC coupling	HF-reject
10 Hz	AC coupling	HF-reject
30 KHz	LF-reject	HF-reject

Example:

`Send → TRIGger:FILTer:HPASs:STATe ON`	Sets High-Pass filter on (HF-reject). Automatically switches Low-Pass filter off.

Front panel compliance:

The TRIGger:FILTer:HPASs commands are the remote equivalent of the front panel TRIGGER MAIN TB - ac, dc, lf-rej, hf-rej soffkey menu.

TRIGger[:SEQuence[1]]:FILTer:LPASs:FREQuency
TRIGger[:STARt]:FILTer:LPASs:FREQuency
TRIGger[:SEQuence[1]]:FILTer:LPASs:STATe
TRIGger[:STARt]:FILTer:LPASs:STATe

Syntax: TRIGger[:SEQuence[1]]:FILTer:LPASs:FREQuency <NRf> | MINimum | MAXimum

TRIGger[:SEQuence[1]]:FILTer:LPASs:STATe <Boolean>

Alias: TRIGger[:STARt]:FILTer:LPASs:FREQuency <NRf> | MINimum | MAXimum

TRIGger[:STARt]:FILTer:LPASs:STATe <Boolean>

<NRf> The cutoff frequency expressed in hertz. Possible values are:

- 0 Defines trigger DC coupling (MINimum).
- 10 Defines trigger AC coupling.
- 30000 Defines LF-reject (MAXimum).

<Boolean>
- 0 | OFF Sets low-pass filter off.
- 1 | ON Sets low-pass filter on.

Query form: TRIGger[:SEQuence[1]]:FILTer:LPASs:FREQuency? MINimum | MAXimum

Alias: TRIGger[:STARt]:FILTer:LPASs:FREQuency? MINimum | MAXimum

Response: 0.00E+00 | 1.00E+01 | 3.0E+04

If MINimum was specified, the minimum possible cutoff frequency is returned, i.e., 0 Hz. If MAXimum was specified, the maximum possible cutoff frequency is returned, i.e., 30 KHz.

Query form: TRIGger[:SEQuence[1]]:FILTer:LPASs:STATe?

Alias: TRIGger[:SEQuence[1]]:FILTer:LPASs:STATe?

Response: 0 | 1

- 0 High-pass filter active (HF-reject).
- 1 Low-pass filter active.

Description:

The TRIGger:FILTer:LPASs:FREQuency command sets the MTB cutoff frequency, which defines the trigger coupling. The specified frequency values are rounded as follows:

```
- 0 ..     4.99   is rounded to  0 Hz, i.e., DC coupling.
- 5 ..  4999.99   is rounded to 10 Hz, i.e., AC coupling.
-      15000      is rounded to 30 KHz, i.e., LF-reject.
```

The TRIGger:FILTer:LPASs:STATe command activates (ON) or deactivates (OFF) the MTB low-pass filter.

Activating the MTB low-pass filter:
- automatically deactivates the MTB high-pass filter.
- sets the high-pass cutoff frequency at bandwidth (100/200 MHz).
- sets the low-pass cutoff frequency at 0 Hz (DC coupling).

DeActivating the MTB low-pass filter:
- automatically activates the MTB high-pass filter.
- sets the high-pass cutoff frequency at 30 KHz.
- sets the low-pass cutoff frequency at 0 Hz.

After a *RST command, the low-pass filter is ON and the cutoff frequency is 0 Hz (DC coupling).

Note: *The following coupling exists between programming the cutoff frequency and (de)-activating the low-pass or high-pass filter:*

	FILTER	
FREQUENCY	LOW-PASS ON	HIGH-PASS ON
0 Hz	DC coupling	HF-reject
10 Hz	AC coupling	HF-reject
30 KHz	LF-reject	HF-reject

Example:

Send → `TRIGger:FILTer:LPASs:STATe ON`

Sets Low-Pass filter on + cutoff frequency = 0 Hz (DC coupling). Automatically switches High-Pass filter off.

Send → `TRIGger:FILTer:LPASs:FREQuency 3E+4`

Sets cutoff frequency = 30 KHz (LF-reject).

Front panel compliance:

The TRIGger:FILTer:LPASs commands are the remote equivalent of the front panel TRIGGER MAIN TB - ac, dc, lf-rej, hf-rej softkey menu.

TRIGger[:SEQuence[1]]:HOLDoff
TRIGger[:STARt]:HOLDoff

Syntax: TRIGger[:SEQuence[1]]:HOLDoff <NRf> | MINimum | MAXimum

Alias: TRIGger[:STARt]:HOLDoff <NRf> | MINimum | MAXimum

<NRf> The hold-off value expressed in percent. The range is from 0.00 (MINimum = 0 %) to 1.00 (MAXImum = 100 %).

Query form: TRIGger[:SEQuence[1]]:HOLDoff? [MINimum | MAXimum]
TRIGger[:STARt]:HOLDoff? [MINimum | MAXimum]

Response: <NR3>

<NR3> The hold-off value in percent.

Description:

The hold-off value specifies the hold-off time after each Main Time Base sweep, during which the MTB event detector is inhibited from acting on any new trigger. For a specification of the minimum and maximum hold-off time, refer to the Reference Manual supplied. In the digital mode the hold-off time is used to process previously captured data.

After a *RST command, the hold-off value is 0 %.

Example:

`Send → TRIGger:HOLDoff 0.5` Hold-off becomes 50 %.

Front panel compliance:

The TRIGger:HOLDoff command is the remote equivalent of the front panel HOLD OFF knob.

TRIGger[:SEQuence[1]]:LEVel
TRIGger[:SEQuence[1]]:LEVel:AUTO
TRIGger[:STARt]:LEVel
TRIGger[:STARt]:LEVel:AUTO

Syntax: TRIGger[:SEQuence[1]]:LEVel <NRf> | MINimum | MAXimum
TRIGger[:SEQuence[1]]:LEVel:AUTO <Boolean>

Alias: TRIGger[:STARt]:LEVel <NRf> | MINimum | MAXimum
TRIGger[:STARt]:LEVel:AUTO <Boolean>

<NRf> The trigger level expressed in volts.

MINimum Selects the minimum possible trigger level.

MAXimum Selects the maximum possible trigger level.

Query form: TRIGger[:SEQuence[1]]:LEVel? [MINimum | MAXimum]

Alias: TRIGger[:STARt]:LEVel? MINimum | MAXimum

Response: <NR3>

<NR3> The trigger level in volts.

Query form: TRIGger[:SEQuence[1]]:LEVel:AUTO?

Alias: TRIGger[:STARt]:LEVel:AUTO?

Response: 0 | 1

0 Level peak-peak off.

1 Level peak-peak on.

Description:

The TRIGger:LEVel command controls the trigger level. The trigger level for the trigger source is effective only if the trigger source is INTernal 1, 2, 3 or 4. The instrument function "level-pp" is automatically switched off. If the trigger source is LINE, execution error -221, "Settings conflict" is generated at receipt of the command. Execution error -221 is also generated if the instrument cannot report the unit in volts upon receipt of the query.

The TRIGger:LEVel:AUTO switches the level peak-peak function on or off. If level peak-peak is switched off, the trigger level is automatically reactivated. If level peak-peak is switched on, the trigger level is automatically deactivated and the level range is clamped within the peaks of the signal.

After a *RST command, tha trigger level is MAXimum and auto level peak-peak is switched off.

Notice that thera exists a coupling batwean programming the attenuator (vertical sensitivity) and the trigger laval. If the attanuator is changad, tha triggar laval is also adaptad to keep tha signal display on the scradded.

Programming tip:

First program the attenuator (SENSe:VOLTage:RANGe:PTPeak), and then the trigger level (TRIGger:LEVel).

Example:

`Send → *RST`	Resets the instrument.
`Send → TRIGger:SOURce INTernal1`	Trigger source becomes channel 1.
`Send → INITiate:CONTinuous ON`	Continuous initiation.
`Send → SENSe:VOLTage:RANGe:PTPeak 8`	1 V/div. sensitivity
`Send → TRIGger:LEVel 0.2`	Trigger level becomes 0.2 V. Level peak-peak is also switched off.
`Send → TRIGger:LEVel:AUTO ON`	Switches level peak-peak on and deactivates the trigger level.

Front panel compliance:

The TRIGger:LEVel command is the remote equivalent of the front panel TRIGGER LEVEL knob. The TRIGger:LEVel:AUTO command is the remote equivalent of the front panel TRIGGER MAIN TB - level-pp on/off softkey menu.

TRIGger[:SEQuence[1]]:SLOPe
TRIGger[:STARt]:SLOPe

Syntax: TRIGger[:SEQuence[1]]:SLOPe POSitive | NEGative | EITHer

Alias: TRIGger[:STARt]:SLOPe POSitive | NEGative | EITHer

POSitive	Positive trigger edge.
NEGative	Negative trigger edge.
EITHer	Triggering is done at a positive and at a negative edge.

Query form: TRIGger[:SEQuence[1]]:SLOPe?
TRIGger[:STARt]:SLOPe?

Response: POS | NEG | EITH

POS	Positive trigger edge.
NEG	Negative trigger edge.
EITH	Trigger edge is both positive and negative.

Description:

Controls the trigger edge (slope) to be detected. The command sets the trigger slope and the query returns the trigger slope. The dual slope mode (EITHer) is only possible, if the following selections are valid:

- the digital mode INSTrument DIGital
- the real-time mode SENSe:SWEep:REALtime ON
- the 'single-shot' mode INITiate:CONTinuous OFF
- the trigger source is INTernal TRIGger:SOURce INTernal1|2|3|4

After a *RST command, the trigger slope is POSitive.

Example:

Send → CONFigure:AC (@2)	Configures AC-RMS CH2.
Send → SENSe:SWEep:REALtime ON	Sets real-time mode on.
Send → TRIGger:SOURce INTernal2	Trigger source becomes channel 2.
Send → TRIGger:LEVel .02	Trigger level becomes 20 mV.
Send → TRIGger:SLOPe EITHer	Triggering is done at positive (rising) and negative (falling) trigger edges.
Send → INITiate	Initiates acquisition.
Send → FETch:AC? (@2)	Fetches AC-RMS value.
Read ← <AC-RMS voltage>	Reads AC-RMS value.

Front panel compliance:

The TRIGger:SLOPe command is the remote equivalent of the front panel TRIG1, TRIG2, TRIG3, and TRIG4 keys and the TRIGGER MAIN TB edge option of the TRIGGER menu.

TRIGger[:SEQuence[1]]:SOURce
TRIGger[:STARt]:SOURce

Syntax: TRIGger[:SEQuence[1]]:SOURce IMMediate | INTernel<n> | EXTernal | LINE | BUS

Alias: TRIGger[:STARt]:SOURce IMMediete | INTernal<n> | EXTernel | LINE | BUS

IMMediate	Immediate sweeping (no waiting for a trigger).
INTernal<n>	Input channel <n> is used as trigger source. <n> = 1, 2, 3 or 4.
EXTernal	Input channel 4 is used as external trigger source (only for PM33x0A).
LINE	The source signal is determined from the AC line voltage.
BUS	Triggering is done by a *TRG command or GET code via the GPIB.

Query form: TRIGger[:SEOuence[1]]:SOURce?
TRIGger[:STARt]:SOURce?

Response: IMM | INT<n> | EXT | LINE | BUS

IMM	Immediate sweeping (no waiting for a trigger).
INT<n>	Input channel <n> used as trigger source. <n> = 1, 2, 3 or 4.
EXT	Input channel 4 used as external trigger source (only for PM33x0A).
LINE	The source signal determined from the AC line voltage.
BUS	Triggering done by a *TRG command or GET code vie the GPIB.

Description:

Controls the trigger source. The command selects the source, and the query returns the source that triggers the acquisition. If e trigger source other than IMMediate, INTernal<n>, LINE, or BUS is ective, execution error -221 is generated at receipt of the query. The dual slope selection (EITHer) is only possible, if the trigger source is INTernal<n> end if in the "reel time" mode (SENSe:SWEep:REALtime ON). If the trigger source becomes BUS, LINE, or IMMediate, the trigger slope selection is changed to POSitive.
After a *RST command, the trigger source is IMMediate for the PM3382A-84A-92A-94A and EXTernal for the PM33x0A CombiScope instruments (if a signal is available at the external trigger input channel).

Example:

`Send → CONFigure:AC (@1)`	Configures AC-RMS CH1.
`Send → TRIGger:SOURce INTernal1`	Input channel 1 becomes the trigger source.
`Send → TRIGger:LEVel 0.2`	Trigger level becomes 0.2V.
`Send → TRIGger:SOURce BUS`	The GPIB becomes the trigger source.
`Send → INITiate`	Single initiation.
`Send → *TRG`	Triggering via the GPIB.
`Send → FETCh:AC?`	Fetches AC-RMS values.
`Read ← <AC-RMS voltage>`	Reads AC-RMS value.

Front panel compliance:

The TRIGger:SOURce command is the remote equivalent of the front panel TRIGGER MAIN TB - chn/line option of the TRIGGER menu.

Programming tip:

For single-shot measurements, the trigger source must be one of the input channels <n> (INTernal<n>), instead of IMMediate (software automatic trigger).

TRIGger[:SEQuence[1]]:TYPE
TRIGger[:STARt]:TYPE

Syntax: TRIGger[:SEQuence[1]]:TYPE EDGE | VIDeo | LOGic

Alias: TRIGger[:STARt]:TYPE EDGE | VIDeo | LOGic | GLITch

EDGE	Selects edge triggering.
VIDeo	Selects TV video triggering.
LOGic	Selects logic triggering (only for PM3382A-84A-92A-94A).
GLITch	Selects glitch triggering (only for PM33x0A).

Query form: TRIGger[:SEQuence[1]]:TYPE?
TRIGger[:STARt]:TYPE?

Response: EDGE | VID | LOG

Description:

The TRIGger:TYPE command controls the type of triggering.
After a *RST command, the trigger type is EDGE (normal triggering).

Example:

Send → `TRIGger:TYPE VIDeo` Selects TV video triggering.

Front panel compliance:

The TRIGger:TYPE command is the remote equivalent of the front panel TRIGGER MAIN TB -edge/tv/logic softkey menu.

TRIGger[:SEQuence[1]]:VIDeo:FIELd[:NUMBer]
TRIGger[:STARt]:VIDeo:FIELd[:NUMBer]
TRIGger[:SEQuence[1]]:VIDeo:FIELd:SELect
TRIGger[:STARt]:VIDeo:FIELd:SELect

Syntax: TRIGger[:SEQuence[1]]:VIDeo:FIELd[:NUMBer] <NRf> | MINimum | MAXimum

TRIGger[:SEQuence[1]]:VIDeo:FIELd:SELect ALL | NUMBer

Alias: TRIGger[:STARt]:VIDeo:FIELd[:NUMBer] <NRf> | MINimum | MAXimum

TRIGger[:STARt]:VIDeo:FIELd:SELect ALL | NUMBer

<NRf> 1 | 2

1 | MINimum	Selects field1 triggering.
2 | MAXimum	Selects field2 triggering.

ALL	Selects lines triggering.
NUMBer	Selects field triggering.

Query form: TRIGger[:SEQuence[1]]:VIDeo:FIELd[:NUMBer]? MINimum | MAXimum

Alias: TRIGger[:STARt]:VIDeo:FIELd[:NUMBer] <NRf> | MINimum | MAXimum

Response: 1 | 2

1	Field1 triggering selected.
2	Field2 triggering selected.

If MINimum was specified, 1 is returned. If MAXimum was specified, 2 is returned.

Query form: TRIGger[:SEQuence[1]]:VIDeo:FIELd:SELect?

Alias: TRIGger[:STARt]:VIDeo:FIELd:SELect?

Response: ALL | NUMB

ALL	Lines triggering selected.
NUMB	Field triggering selected.

Description:

The TRIGger:VIDeo:FIELd:SELect command programs the video trigger mode to "field" or "lines". The TRIGger:VIDeo:FIELd[:NUMBer] command selects between "field1" and "field2".
After a *RST command, lines triggering (ALL) and field number 1 is selected.

Notice that there exists a coupling between selecting field1/field2 using the TRIGger:VIDeo:FIELd[:NUMBer] command and selecting the line number using the TRIGger:VIDeo:LINE command. Programming the line number automatically sets the field1/2 triggering, and programming field1/2 recalculates the selected line number as follows:

> from field1 (1 .. 312) to field2:	line_nr = line_nr + 625/2
> from field2 (313 .. 625) to field1:	line_nr = line_nr - 625/2

Example:

`Send → TRIGger:TYPE VIDeo`	Selects TV video triggering.
`Send → TRIGger:VIDeo:FIELd:SELect ALL`	Selects video lines trigger mode.
`Send → TRIGger:VIDeo:LINE 123`	Selects video line number 123.
`Send → TRIGger:VIDeo:FIELd:SELect NUMBer`	Selects video field triggering. Line number 123 selects field1 (field1 = lines 1 .. 312).
`Send → TRIGger:VIDeo:FIELd:NUMBer 2`	Selects video field2 trigger mode. As a result the video line number is automatically switched to 435 (= 123 + 625/2).
`Send → TRIGger:VIDeo:LINE 325`	Selects video line number 325.
`Send → TRIGger:VIDeo:FIELd:NUMBer 1`	Selects the video field1 trigger mode. As a result the video line number is automatically switched to 13 (= 325 - 625/2).

Front panel compliance:

The TRIGger:VIDeo:FIELd:SELect and TRIGger:VIDeo:FIELd[:NUMBer] commands are the remote equivalent of the front panel TRIGGER MAIN TB - tv - field1/field2/lines softkey menu.

TRIGger[:SEQuence[1]]:VIDeo:FORMat[:TYPE]:LPFRame
TRIGger[:STARt]:VIDeo:FORMat[:TYPE]:LPFRame
TRIGger[:SEQuence[1]]:VIDeo:FORMat[:TYPE]
TRIGger[:STARt]:VIDeo:FORMat[:TYPE]

Syntax: TRIGger[:SEQuence[1]]:VIDeo:FORMat[:TYPE]:LPFRame <NRf> | MINimum | MAXimum

TRIGger[:SEOuence[1]]:VIDeo:FORMat[:TYPE] PAL | SCAM | SECAM | NTSC | HDTV

Alias: TRIGger[:STARt]:VIDeo:FORMat[:TYPE]:LPFRame <NRf> | MINimum | MAXimum

TRIGger[:STARt]:VIDeo:FORMat[:TYPE] PAL | SCAM | SECAM | NTSC | HDTV

<NRf> 525 | 625 | 1050 | 1125 | 1250

525 | MINimum	Selects 525 lines per frame (NTSC).
625	Selects 625 lines per frame (PAL or SECAM). PAL is default if previous selection was not SECAM.
1050	Selects 1050 lines per frame (HDTV).
1125	Selects 1125 lines per frame (HDTV).
1250 | MAXimum	Selects 1250 lines per frame (HDTV).

PAL Selects PAL standard (625 lines/frame).

SCAM | SECAM Selects SECAM standard (625 lines/frame).

NTSC Selects NTSC standard (525 lines/frame).

HDTV Selects HDTV standard (1050/1125/1250 lines/frame).

Query form: TRIGger[:SEQuence[1]]:VIDeo:FORMat[:TYPE]:LPFRame? MINimum | MAXimum

Alias: TRIGger[:STARt]:VIDeo:FORMat[:TYPE]:LPFRame? MINimum | MAXimum

Response: 525 | 625 | 1050 | 1125 | 1250

525	NTSC standard selected (525 lines/frame).
625	PAL (default) or SECAM standard selected (625 lines/frame).
1050	HDTV standard selected (1050 lines/frame).
1125	HDTV standard selected (1125 lines/frame).
1250	HDTV standard selected (1250 lines/frame).

The minimum and maximum number of lines per frame depends on the TV standard specified. If, for example, HDTV was selected, MINimum returns 1050 and MAXimum returns 1250.

Query form: TRIGger[:SEQuence[1]]:VIDeo:FORMat[:TYPE]?

Alias: TRIGger[:STARt]:VIDeo:FORMat[:TYPE]?

Response: PAL | SCAM | NTSC | HDTV

PAL	PAL standard (625 lines/frame) selected.
SCAM	SECAM standard (625 lines/frame) selected.
NTSC	NTSC standard (525 lines/frame) selected.
HDTV	HDTV standard (1050/1125/1250 lines/frame) selected.

Description:

The TRIGger:VIDeo:FORMat[:TYPE] command selects the standard video system. The TRIGger:VIDeo:FORMat:LPFRame command does the same by specifying the number of video lines, which also results in the selection of a video standard. The number specified is rounded as follows:

0	..	575	→	525	→	NTSC
576	..	837	→	625	→	PAL/SECAM (PAL is default)
838	..	1087	→	1050	→	HDTV
1088	..	1187	→	1125	→	HDTV
	>=	1118	→	1250	→	HDTV

After a *RST command, lines triggering (ALL) and field number 1 are selected.

Example:

Send → `TRIGger:VIDeo:FORMat NTSC`	Selects NTSC, 525 lines/frame.
Send → `TRIGger:VIDeo:FORMat PAL`	Selects PAL, 625 lines/frame.
Send → `TRIGger:VIDeo:FORMat SECAM`	Selects SECAM, 625 lines/frame.
Send → `TRIGger:VIDeo:FORMat:LPFRame 1050`	Selects HDTV, 1050 lines/frame.
Send → `TRIGger:VIDeo:FORMat:LPFRame 1125`	Selects HDTV, 1125 lines/frame.
Send → `TRIGger:VIDeo:FORMat:LPFRame 1250`	Selects HDTV, 1250 lines/frame.

Front panel compliance:

The TRIGger:VIDeo:FORMat:... commands are the remote equivalent of the front panel TRIGGER MAIN TB - VIDEO SYSTEM - hdtv/ntsc/pal/secam softkey menu.

TRIGger[:SEQuence[1]]:VIDeo:LINE
TRIGger[:STARt]:VIDeo:LINE
TRIGger[:SEQuence[1]]:VIDeo:SSIGnal[:POLarity]
TRIGger[:STARt]:VIDeo:SSIGnal[:POLarity]

Syntax: TRIGger[:SEQuence[1]]:VIDeo:LINE <NRf>
| MINimum | MAXimum
TRIGger[:SEOuence[1]]:VIDeo:SSIGnal[:POLarity]
POSitive | NEGative

Alias: TRIGger[:STARt]:VIDeo:LINE <NRf> | MINimum | MAXimum
TRIGger[:STARt]:VIDeo:SSIGnal[:POLarity] POSitive | NEGative

<NRf>	1 .. 1250	
	1 | MINimum	Selects video line 1.
	1250 | MAXimum	Selects video line 1250 (only for HDTV).
POSitive	Selects positive video signal polarity.	
NEGative	Selects negative video signal polarity.	

Query form: TRIGger[:SEOuence[1]]:VIDeo:LINE? MINimum | MAXimum

Alias: TRIGger[:STARt]:VIDeo:LINE? MINimum | MAXimum

Response: 1 .. 1250

The minimum and maximum number of lines per frame depends on the TV standard specified. If, for example, HDTV was selected, MINimum returns 1 and MAXimum returns 1250.

Query form: TRIGger[:SEQuence[1]]:VIDeo:SSIGnal[:POLarity]?

Alias: TRIGger[:STARt]:VIDeo:SSIGnal[:POLarity]?

Response: POS | NEG

POS	Positive video signal polarity selected.
NEG	Negative video signal polarity selected.

Description:

The TRIGger:VIDeo:LINE command selects the video line number. Depending on the video system selected, the following ranges are valid:

> NTSC	from 1 to 525
> PAL or SECAM	from 1 to 625
> HDTV	from 1 to 1250

The TRIGger:VIDeo:SSIGnal command selects the video signal polarity.

After a *RST command, video line number 1 and signal polarity POSitive are selected.

Example:

`Send → TRIGger:TYPE VIDeo`	Selects TV video triggering.
`Send → TRIGger:VIDeo:LINE 123`	Selects video line number 123.
`Send → TRIGger:VIDeo:SSIGnal NEGative`	Selects negative video signal polarity.

Front panel compliance:

The TRIGger:VIDeo:LINE command is the remote equivalent of the front panel TRIGGER MAIN TB - LINE NBR softkey menu. The TRIGger:VIDeo:SSIGnal command is the remote equivalent of the front panel TRIGGER MAIN TB - pos/neg softkey menu.

APPENDIX A
APPLICATION PROGRAM EXAMPLES

The program examples are written for the CombiScopes with the IEEE option installed. No other instrument is required to execute these examples. For system and programming environment requirements to execute these examples, refer to section 2.1 "Preparations for SCPI programming".

Note: All APPLICATION PROGRAM EXAMPLES in this chapter are supplied on floppy.

- The following error handling routine is used:

```
' ***************************************************
' Subroutine reading all errors from the error queue.
' ***************************************************
SUB errorcheck
  er$ = SPACE$(1)
  WHILE LEFT$(er$, 1) <> "0"
    CMD$ = "SYSTem:ERRor?"
    CALL Send(0, 8, CMD$, 1)          ' Sends error query
    er$ = SPACE$(60)
    CALL Receive(0, 8, er$, 256)      ' Reads error string
    PRINT "error = "; er$             ' Displays error string
  WEND
END SUB
```

- Error reporting is invoked as follows: **CALL errorcheck**
- In the command strings the "short form" commands are specified in capitals. The additional characters in lower case complete the "long form commands.

A.1 Measuring Signal Characteristics

Measuring signal characteristics can be done in either of the following ways:

1) Using the meesurement Instructions. Example A.1.1 shows how to do thet automatically by letting the CombiScope instrument select the best possible settings. Exemple A.1.2 shows how to do that after progremming your own instrument settings.

2) Using the DISPlay:WINDow:TEXT<n>:DATA? query to read signal values as measured by the MEAS1 & MEAS2 features of the CombiScope instrument (refer to example A.1.3).

A.1.1 Making automatic measurements

In the following example the frequency, amplitude, period, positive and negative pulse width of the Probe Adjust signal are measured and displayed 10 times. This is done automatically by using the CONFigure, READ?, and FETCh? measurement instructions.

Application summary:

- Connect a 10:1 probe between channel 1 and the Probe Adjust signal (2000 Hz, 600 mV).
- Configure for measuring the Probe Adjust voltage of 600 mV and frequency of about 2000 Hz by sending:
  CONFigure:VOLTage:FREOuency (0.6),2000,(@1)
- Send the following queries 10 times and read the corresponding responses:

READ:FREOuency?	Initiates and fetches a frequency measurement.
FETCh:AMPLitude?	Fetches the measured amplitude.
FETCh:PERiod?	Fetches the measured period.
FETCh:PWIDth?	Fetches the measured positive pulse width.
FETCh:NWIDth?	Fetches the measured negative pulse width.

- Print the received signal characteristics. Notice that the sum of the positive and negative pulse width equals the period, and that the inverse period equals the frequency.

Application program:

Note: The program is also supplied on floppy under file name EXAPPA11.BAS.

```
REM $INCLUDE: 'QBDECL.BAS'
DECLARE SUB errorcheck ()
DIM res AS STRING * 100                 ' Dimension response string
DIM cmd AS STRING                       ' Declare command string
EndEOI% = 1                             ' Termination Send on LineFeed & EOI
```

```
StopEOI% = 256                          ' Termination Receive on EOI
CLS                                     ' Clears Output Screen
CALL SendIFC(0)                         ' Clears the GPIB interface
CALL IBTMO(0, 13)                       ' Timeout at 10 seconds
'
'*** Reset the instrument and clear the status data.
cmd$ = "*RST;*CLS"
CALL Send(0, 8, cmd$, EndEOI%)
CALL errorcheck
'
'*** Configure for measuring the frequency of the Probe signal.
cmd$ = "CONFigure:VOLTage:FREQuency (0.6),2000,(@1)"
CALL Send(0, 8, cmd$, EndEOI%)
PRINT "Frequency Amplitude Period Pos.width Neg.width"
PRINT " Hertz Volts seconds seconds seconds"
PRINT
'.
'*** Read the signal characteristics 10 times.
FOR i = 1 TO 10
  cmd$ = "READ:FREQuency?"
  CALL Send(0, 8, cmd$, EndEOI%)
  CALL Receive(0, 8, res$, StopEOI%)          ' Enters frequency
  PRINT LEFT$(res$, INSTR(res$, CHR$(10)) - 1),
  '
  cmd$ = "FETCh:AMPLitude?"
  CALL Send(0, 8, cmd$, EndEOI%)
  CALL Receive(0, 8, res$, StopEOI%)          ' Enters amplitude
  PRINT LEFT$(res$, INSTR(res$, CHR$(10)) - 1),
  '
  cmd$ = "FETCh:PERiod?"
  CALL Send(0, 8, cmd$, EndEOI%)
  CALL Receive(0, 8, res$, StopEOI%)          ' Enters period
  PRINT LEFT$(res$, INSTR(res$, CHR$(10)) - 1),
  '
  cmd$ = "FETCh:PWIDth?"
  CALL Send(0, 8, cmd$, EndEOI%)
  CALL Receive(0, 8, res$, StopEOI%)          ' Enters positive pulse width
  PRINT LEFT$(res$, INSTR(res$, CHR$(10)) - 1),
  '
  cmd$ = "FETCh:NWIDth?"
  CALL Send(0, 8, cmd$, EndEOI%)
  CALL Receive(0, 8, res$, StopEOI%)          ' Enters negative pulse width
  PRINT LEFT$(res$, INSTR(res$, CHR$(10)) - 1)
NEXT i
PRINT
CALL errorcheck
END
```

A.1.2 Making programmed measurements

In the following axampla the ovarshoot value on the rising edga of tha Probe Adjust signal is maasurad. This is done by programming the input conditions in tha RUN moda (INITiate:CONTinuous ON), followed by a single-shot measuremant of tha paak-to-peak (PTPaak) value and the rise tima overshoot parcentaga (RISE:OVERshoot). Tha risa time overshoot value is calculated from the rise time overshoot percentage as follows:

- Rise time overshoot = $\dfrac{\text{PTPeak} * \text{RISE:OVERshoot}}{100}$ V

Application summary:

- Connect a 10:1 probe between channel 1 and the Probe Adjust signal (2000 Hz, 600 mV).
- Program the following input conditions:
  - AC input coupling
  - Continuous trigger initiation (RUN mode).
  - Trigger source channel 1.
  - Trigger level zero to get a stable signal.
  - Sweep time of 1 ms (100 μs/div.) to obtain two Probe Adjust signal periods on the display.
  - Peak-to-peak value of 1.6V (0.2 V/div.) to keep the positive and negative edge on the display.
- Stop the program to make an overshoot on the Probe Adjust signal. This can be done by turning the screw on the head of the probe.
- Measure and print the peak-to-peak value.
- Measure the rise time overshoot percentage.
- Calculate and print the rise time overshoot value.

Application program:

Note: *The program is supplied on floppy under file name EXAPPA12.BAS.*

A.1.3 Reading measurement values

In the following example measurement values are read into the computer as calculated by the front panel MEAS1 and MEAS2 features during a single-shot measurement.

Application summary:

- Configure for measuring AC-RMS by sending: CONFigure:AC
  and initiate a single-shot by sending: INITiate
- Then stop program execution to let you select the following MEAS values via the front panel:
  > MEAS1-volt-dc
  > MEAS2-time-frequency
- After printing the read measurement values, stop program execution again to let you select the following MEAS values via the front panel:
  > MEAS1-volt-rms
  > MEAS2-time-period

Application program:

Note: *The program is supplied on floppy under file name EXAPPA13.BAS.*

A.2 Acquiring Waveform Traces

In the following example a channel 1 trace of maximum 4096 samples of 1 or 2 bytes is read, converted to voltage values, and printed in portions of 90 samples.

Application summary:

- Read the channel 1 trace by sending: TRACe? CH1
- Convert the binary trace samples to integer values (refer to section 3.4.3.1 and 3.4.3.2).
- Read the peak-to-peak range by sending: SENSe:VOLTage:RANGe:PTPeak?
- Read the offset voltage by sending: SENSe:VOLTage:RANGe:OFFSet?
- Convert the integer values to voltage values (refer to section 3.4.3.3) and print them in portions of 90 samples.

Application program:

Note: *The program is supplied on floppy under file name EXAPPA2.BAS.*

A.3 Saving/Recalling Instrument Setups

The following examples use the save/recell features for instrument setups. Seving and recalling cen be done via internal memory (refer to A.3.1) end remotely vie computer disk space (refer to A.3.2). These features cen be used for non-supported functions, e.g., Cursor Measurements. Before executing one of the programs in section A.3.1 or A.3.2, a cursor measurement setup must be done by hand via the front panel.

A.3.1 Save/recall settings to/from internal memory

The following example uses the save/recall feature to/from internal instrument memory.

1) The program requests to save the current instrument setup to a memory location that must be entered if you respond with Y(es).

2) The program requests to recall an instrument setup from a memory location that must be entered if you respond with Y(es).

3) A single-shot cursor measurement is done. Using the service request mechanism (SRQ) the end of the measurement is waited for. Then, as an example, the "dT cursor" readout value is read and printed.

4) Finally the program asks to stop or to perform a next measurement.

Application summary:

- Before running the program, make a cursor measurement setup via the front panel CURSORS key and menu.
- Enable the SRQ mechanism to generate an interrupt after "Operation Completed" (routine ServReq is executed).
- Request to save the current Instrument setup. If response = Y(es), routine Save.Setup is called.
- Request to recall an Instrument setup. If response = Y(es), routine Enter.Setup is called.
- Repeat.test1:
  Initiate e single acquisition by sending: INITiete:CONTinuous OFF
  INITiete;*OPC
- If en SRQ Is genereted (ecquisition finished), the dT cursor value is reed and printed by sending: DISPlay:WINDow:TEXT20:DATA?
  Request to stop or to repeet this test (do Repeet.test1 again).

- Routine ServReq does the following:
  - Serial polls the status byte to reset the SRQ mechanism.
  - Reeds the ESR byte to clear the OPC bit.
  - Sets the SRQ.detected flag to signel that an SRQ interrupt occurred.
- Routine Enter.Setup does the following:
  - Requests for an internal memory (<n>) from 0 to 10.
  - Sends the *RCL <n> commend to recall the memory setup.
- Routine Save.Setup does the following:
  - Requests for an internal memory (<n>) from 1 to 10.
  - Sends the *SAV <n> command to save the setup into memory.

Application program:

Note: The program is supplied on floppy under file name EXAPPA31.BAS.

A.3.2 Save/recall settings to/from computer disk memory

The following example uses the store/restore feature to/from computer disk space.

1) The program requests to store the current instrument setup to a file name on disk that must be entered if you respond with Y(es).

2) The program requests to restore an instrument setup from a file name on disk that must be entered if you respond with Y(es).

3) A single-shot cursor measurement is done. Using the service request mechanism (SRQ) the end of the measurement is waited for. Then, as an example, the "dT cursor" readout value is read and printed.

4) Finally the program asks to stop or to perform a next measurement.

Application summary:

- Before running the program, make a cursor measurement setup via the front panel CURSORS key and menu.
- Enable the SRQ mechanism to generate an interrupt after "Operation Completed" (routine ServReq is executed).
- Request to save the current instrument setup. If response = Y(es), routine Save.Setup is celled.
- Request to read an instrument setup. If response = Y(es), routine Enter.Setup is called.
- Repeat.test1:
  Initiate a single ecquisition by sending: INITiate:CONTinuous OFF
  INITiate;*OPC

- If an SRQ is generated (acquisition finished), the dT cursor value is read and printed by sending: DISPlay:WINDow:TEXT20:DATA?
  Request to stop or to repeat this test (do Repeat.test1 again).
- Routine ServReq does the following:
  - Serial polls the status byte to reset the SRQ mechanism.
  - Reads the ESR byte to clear the OPC bit.
  - Sets the SRQ.detected flag to signal that an SRQ interrupt occurred.
- Routine Enter.Setup does the following:
  - Requests for a path/directory/file_name.
  - Inputs the instrument settings (<setupout$>) from the file specified.
  - Sends the SYSTem:SET <setupout$> command to restore the instrument setup.
- Routine Save.Setup does the following:
  - Requests for a path/directory/file_name.
  - Sends the SYSTem:SET? query and reads in response the <setupin$> instrument setup.
  - Writes the instrument settings (<setupin$>) to the file specified.

Application program:

Note: *The program is supplied on floppy under file name EXAPPA32.BAS.*

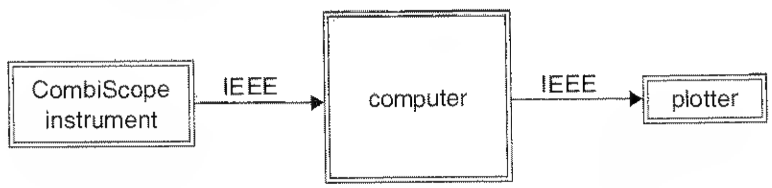
A.4 Making a Hardcopy of the Screen

In the following example a hardcopy of the screen pictura is made as follows:

1) Enter the hardcopy of the screen in HPGL data format.

2) Send tha entered data buffer to a HPGL plotter connected via the IEEE bus.

Application summary:



- Connect the HPGL plotter to the computer via the GPIB interface.
- Turn off the power of the HPGL plotter to prevent the plotter from starting to plot during the data transport from the CombiScope instrument to the computer.
- Create the picture (waveforms + text) on the screen that you want to hardcopy to the plotter. The CombiScope instrument must be in its digital mode (DSO).
- Select the hardcopy HPGL format by sending: HCOPy:DEVice HPGL
- Enter the hardcopy HPGL data by sending: HCOPy:DATA?
  and by reading the response data, i.e.: #0<hardcopy data>.
- Stop program execution to let you turn on the power of the HPGL plotter.
- Finally send the HPGL <hardcopy data> to the HPGL plotter. As a result the picture of the screen is plotted on the plotter paper.

Application program:

Note: The program is supplied on floppy under file name EXAPPA4.BAS.

A.5 Pass/Fail Testing

The following examples use the SYSTem:SET command for storing and restoring instrument setups, which can be used for non-supported functions, such as, Pass/Fail Testing. Before executing one of the programs, a pass/fail test setup must be created by hand via the front panel, including:

1) Generation of a signal that must be tested.

2) Creation of an envelope that must be stored in one of the memory registers, e.g. m2.
   Front panel: MEASURE > PASS/FAIL > TEST (envel) > etc.

3) Definition of the action to be taken on a passing or failing waveforms, e.g. save failing waveforms to e.g., m3.
   Front panel: MEASURE > PASS/FAIL > ACTION (save) > etc.

4) Execution of the example program(s) of the following subsections to save, restore, or run the Pass/Fail test setup that you created before:
   - Section A.5.1 describes how to save the Pass/Fail test setup.
   - Section A.5.2 describes how to restore the Pass/Fail test setup.
   - Section A.5.3 describes how to run the Pass/Fail test setup.

A.5.1 Saving a pass/fail test setup

In the following example the pass/fail test setup information is saved to a file on disk. The name of the file, plus the memory register where the envelope is stored are requested. The layout of the file on disk is as follows:

<number of system settings bytes>	
<system settings bytes>	indefinite length format
<memory_register of the envelope>	e.g., 2_1
<number of envelope trace bytes>	
<envelope trace bytes>	definite length format

Application summary:

- Create a complete Pass/Fail test setup.
- Request the file name in which to save the current instrument setup and open the file for output.
- Call routine Save.Setup to save the instrument settings.
- Call routine Save.Envreg to save the reference envelope.
- Routine Save.Setup does the following:
  - Requests the instrument settings by sending: SYSTem:SET? and by reading the response data (setupin$).
  - Writes the length, plus data to the opened file.

- Routine Save.Envreg does the following:
  - Requests for a memory register to read the envelope from, e.g. 2_1.
  - Requests the reference envelope by sending e.g.: TRACe? M2_1 end by reading the envelope data (envelope$).
  - Writes the envelope register, length, plus date to the opened file.
- Close the opened file.

Application program:

Note: *The Q(uick)BASIC program is supplied on floppy under file name EXAPPA51.BAS. The program code that runs under TestTeam Plus and LabWindows is supplied on floppy under file name EXAPPB51.BAS.*

A.5.2 Restoring a pass/fail test setup

In the following example the pass/fail test setup information, as saved in section A.5.1, is restored from a file on disk. The name of the file is requested. The layout of the file on disk is described in section A.5.1.

Application summary:

- Request the file name from which to restore the instrument setup and open the file for input.
- Call routine Enter.Setup to restore the instrument settings.
- Call routine Enter.Envreg to restore the reference envelope.
- Routine Enter.Setup does the following:
  - Reads the length of the settings data from the opened file.
  - Reads the settings data byte after byte from the opened file (setupout$).
  - Restores the instrument settings by sending: SYSTem:SET <setupout$>
- Routine Save.Envreg does the following:
  - Reads the envelope register from the opened file (envreg$).
  - Reads the length of the envelope data from the opened file.
  - Reads the envelope data byte after byte from the opened file (envelope$).
  - Restores the reference envelope by sending:
    TRACe M<envreg>,<envelope$>
- Close the opened file.

Application program:

Note: *The Q(uick)BASIC program is supplied on floppy under file name EXAPPA52.BAS. The program code that runs under TestTeam Plus and LabWindows is supplied on floppy under file name EXAPPB52.BAS.*

A.5.3 Running a pass/fail test

In the following example the current pass/fail test setup is started and monitored. During monitoring, use is made of the pass/fail status bit (bit 10) in the OPERation status register to detect a failing waveform. The OPERation bit (bit 7) in the standard status byte is used to generate a service request (SRQ) when a failing waveform is detected. If so, the failing waveform is read from memory register 3.1, and stored on disk under file name FAILTRAC.DAT. In this example, this is repeated for five failing waveforms.

Application summary:

- Enable the pass/fail status bit (bit 10 = value 1024) in the OPERation status register to be reported by sending: STATus:OPERation:ENABle 1024
- Enable the OPERation status event bit (bit 7 = value 128) in the standard status byte (STB) to be reported by sending: *SRE 128
- Enable the SRQ mechanism to generate an interrupt after "OPERation event" (routine ServReq is executed).
- Open the file FAILTRAC.DAT for output.
- Start pass/fail checking by sending:

DISPlay:MENU MEASure	Enables display of MEASURE menu.
SYSTem:KEY 6	Selects PASS/FAIL.
SYSTem:KEY 5	Sets PASS/FAIL at run.
DISPlay:MENU:STATe OFF	Disables display of MEASURE menu.

- Let the program execution sleep (or do something else) to wait for a service request to be generated at the occurrence of a failing waveform.
- If an SRQ is generated (failing waveform), do the following:
  - Stop pass/fail checking by sending:

DISPlay:MENU MEASure	Enables display of MEASURE menu.
SYSTem:KEY 6	Selects PASS/FAIL.
SYSTem:KEY 5	Sets PASS/FAIL at stop.

  - Read the failing waveform from memory 3.1 by sending: TRACe? M3_1 and by reading the response trace data.
  - Write the trace data buffer to the opened file FAILTRAC.DAT.
  - Start pass/fail checking again by sending:

SYSTem:KEY 5	Sets PASS/FAIL at run.
DISPlay:MENU:STATe OFF	Disables display of MEASURE menu.

  - Repeat this test 5 times.
- Routine ServReq does the following:
  - Serial polls the status byte to reset the SRQ mechanism.
  - Reads the OPERation event status register to clear the FAIL bit.
  - Sets the SRQ.detected flag to signal that an SRQ interrupt occurred.

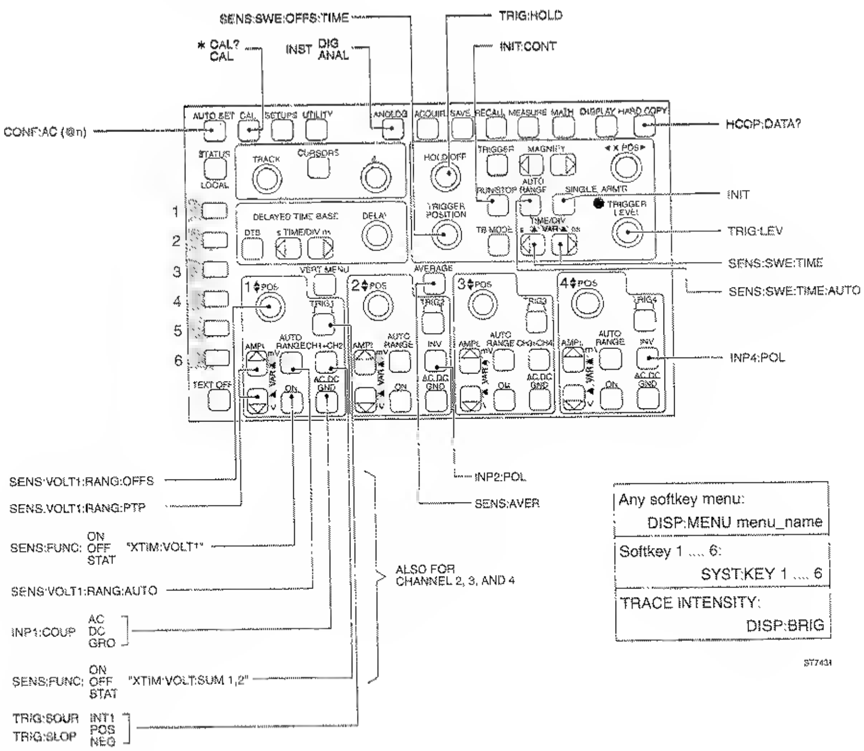
Application program:

Note: *The Q(uick)BASIC program is supplied on floppy under file name EXAPPA53.BAS. The program code that runs under TestTeam Plus and LabWindows is supplied on floppy under file name EXAPPB53.BAS.*

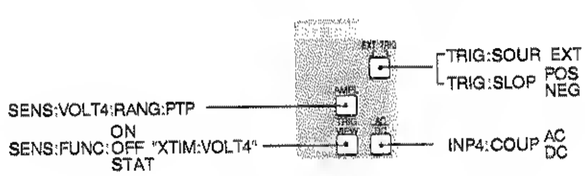
APPENDIX B CROSS REFERENCES

B.1 Cross Reference Front Panel Keys / Commands

The front panel picture is copied from the operation guide, showing the SCPI commands corresponding to front panel keys.



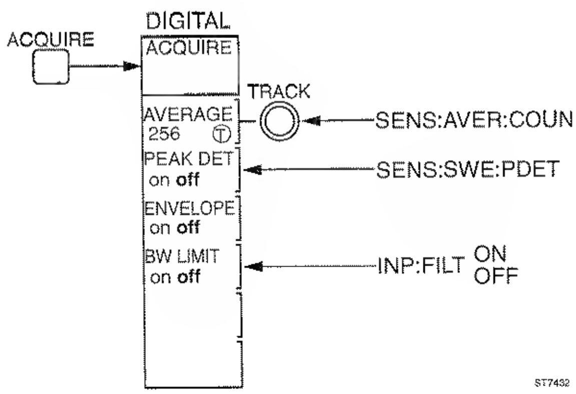
Notes: - *Channel 3 is not applicable for PM33x0A.*
- *Channel 4 is external trigger input for PM33x0A.*



B.2 Cross Reference Softkey Menus / Commands

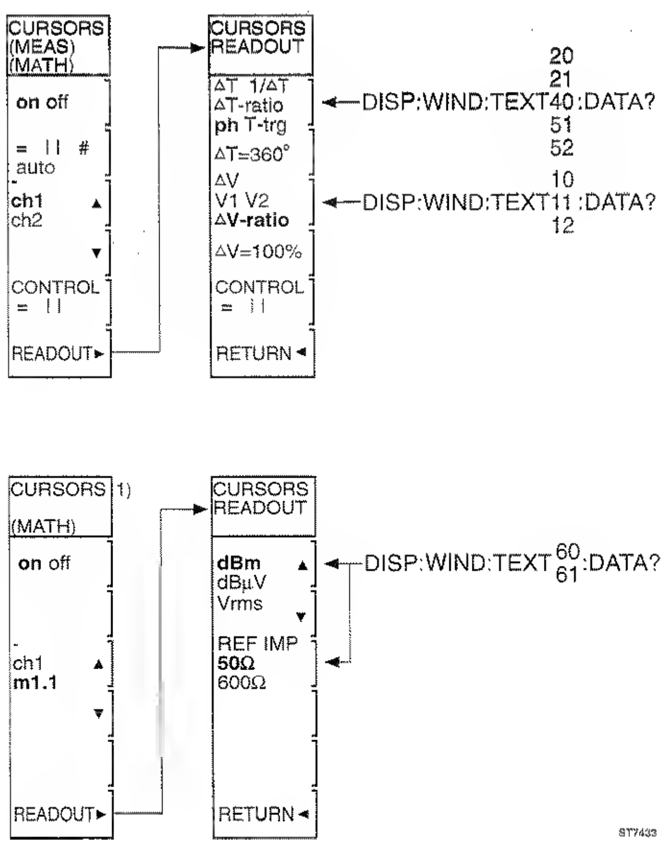
The menu pictures are copied from or refer to menus in the operation guide. The relationship to the corresponding SCPI command(s) is also shown.

B.2.1 ACQUIRE menu

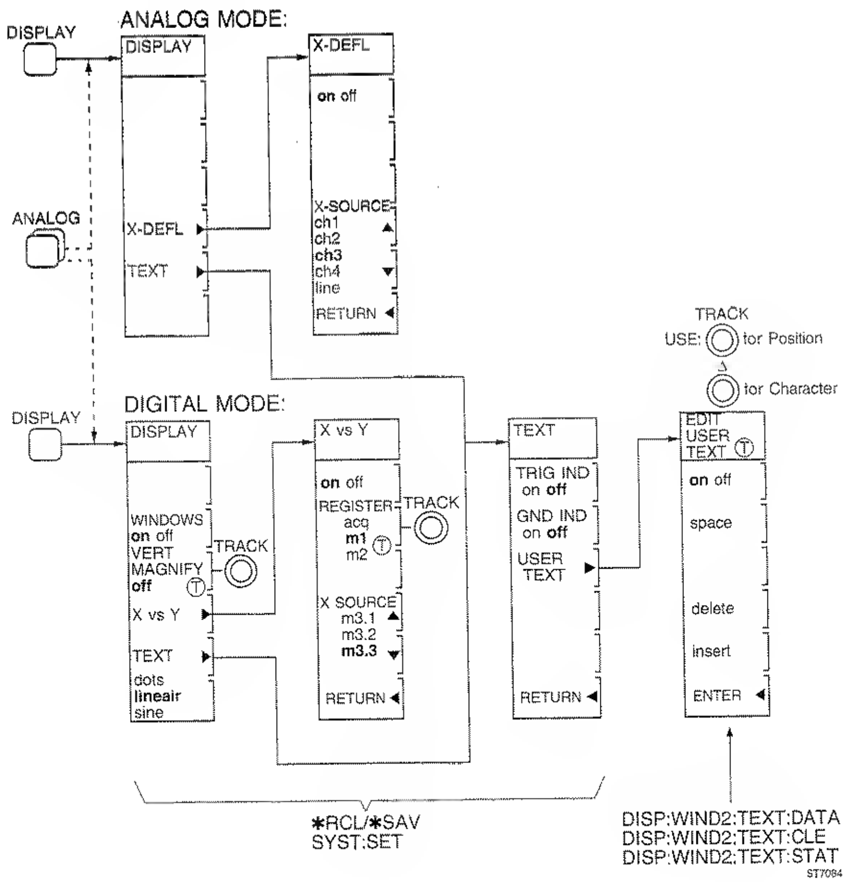


B.2.2 CURSORS menu

Programmable with the *SAV/*RCL and SYST:SET commands.

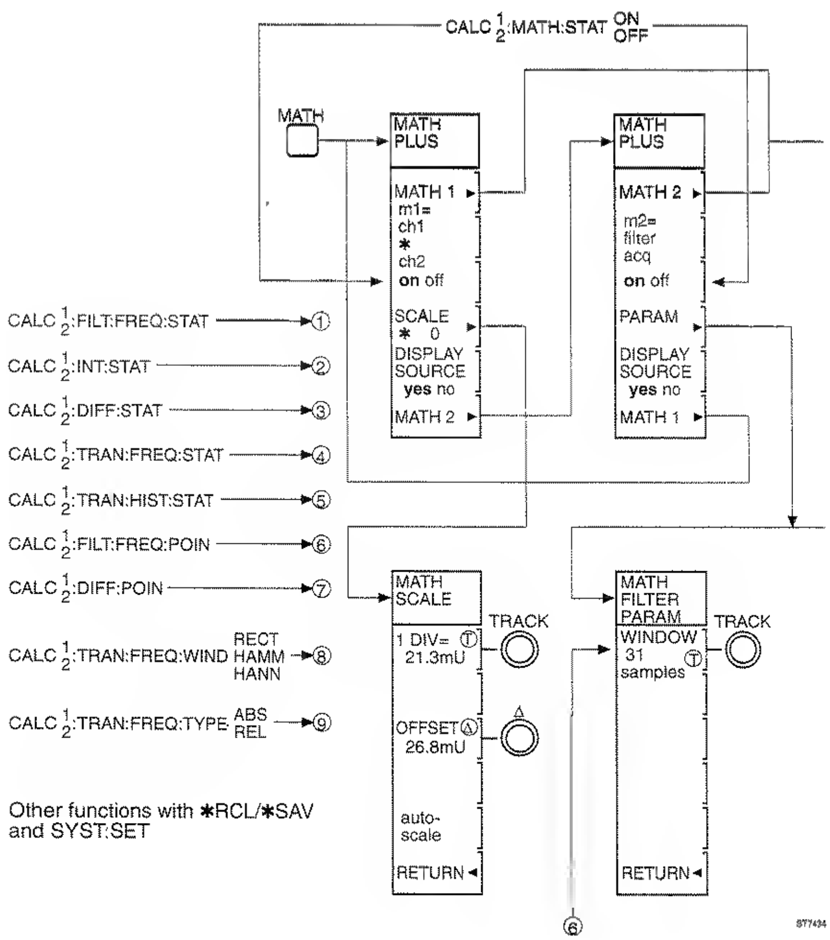


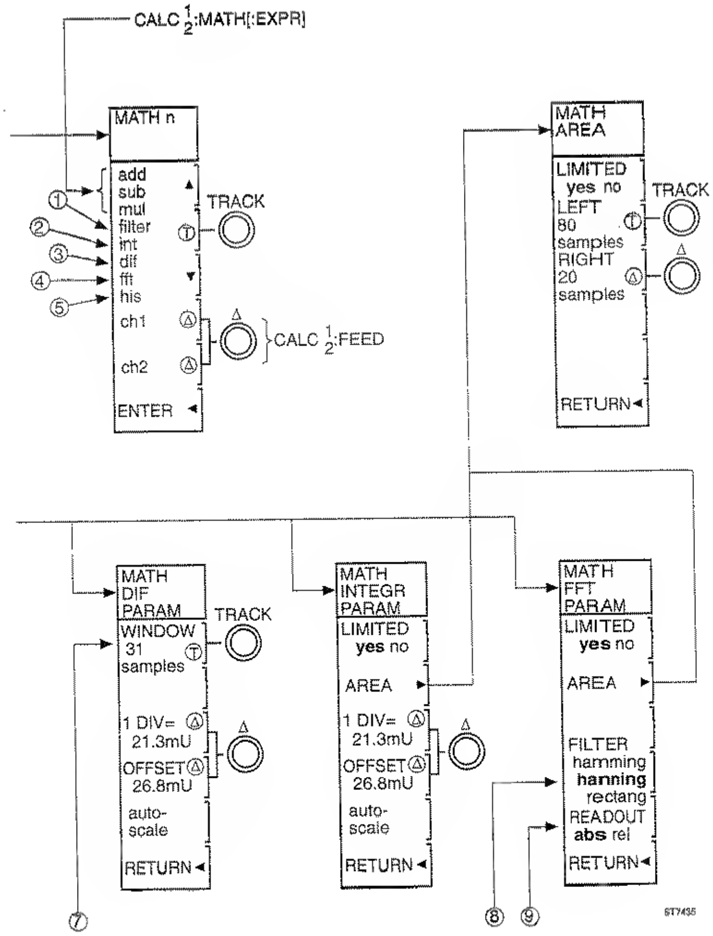
B.2.3 DISPLAY menu



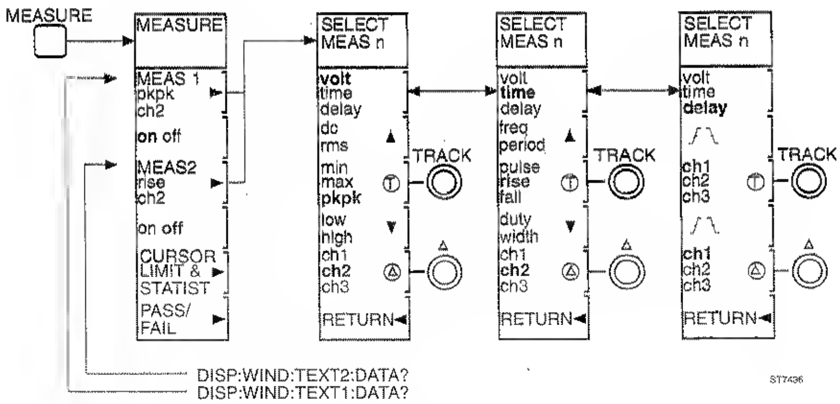
Notes:
- *ch3 is not applicable for PM33x0A.*
- *ext instead of ch4 for PM33x0A.*

B.2.4 MATHPLUS MATH menu




CALC 1/2:MATH[:EXPR]
MATH n
add
sub
mul
filter
int
dif
fft
his
ch1
ch2
ENTER
TRACK
CALC 1/2:FEED
1
2
3
4
5
MATH AREA
LIMITED
yes no
LEFT
80
samples
RIGHT
20
samples
RETURN
TRACK
MATH DIF PARAM
WINDOW
31
samples
1 DIV=
21.3mU
OFFSET
26.8mU
auto-
scale
RETURN
TRACK
7
MATH INTEGR PARAM
LIMITED
yes no
AREA
1 DIV=
21.3mU
OFFSET
26.8mU
auto-
scale
RETURN
MATH FFT PARAM
LIMITED
yes no
AREA
FILTER
hamming
hanning
rectang
READOUT
abs rel
RETURN
8
9
ST7435

B.2.5 MEASURE menu

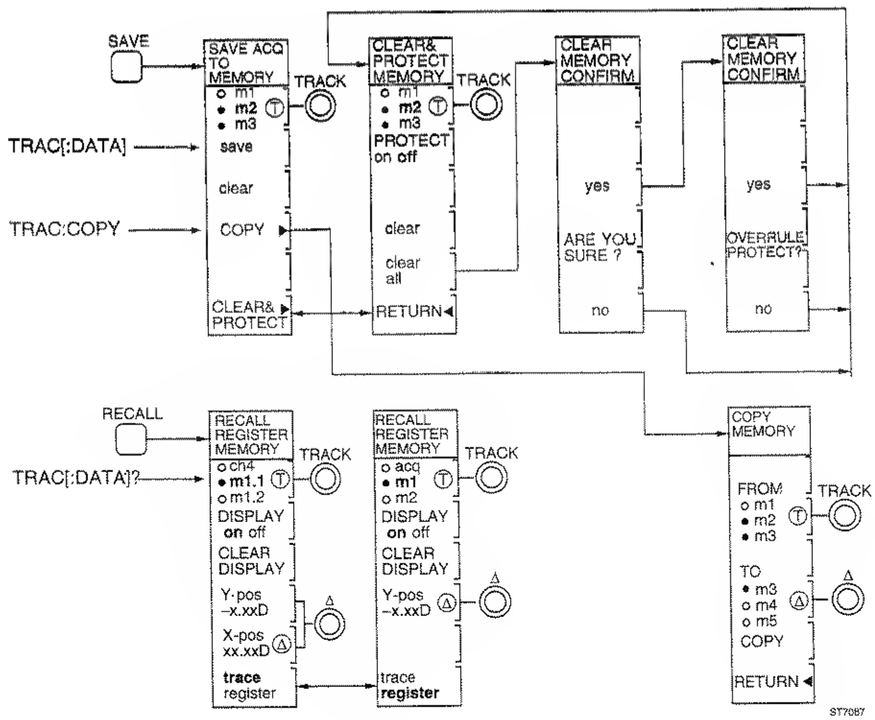


Notes: - *ch3 is not applicable for PM33x0A.*
- *ext instead of ch4 for PM33x0A.*

B.2.6 DTB (DEL'D TB) menu

Programmable with the *SAV/*RCL and SYST:SET commands.

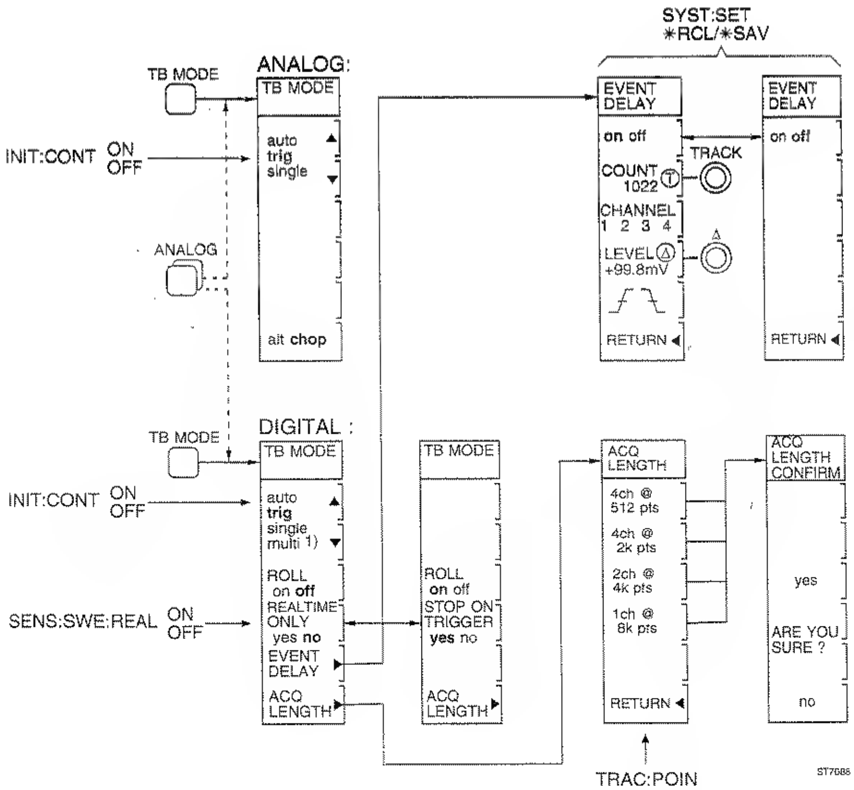
B.2.7 SAVE/RECALL menu



B.2.8 SETUPS menu

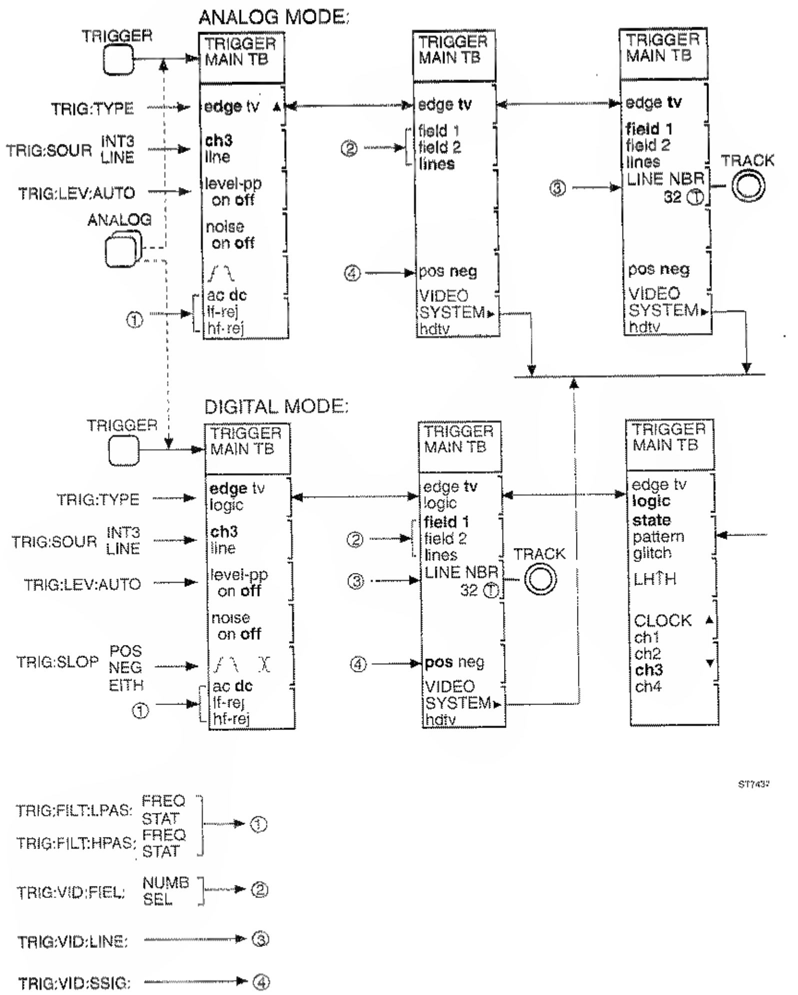
Programmable with the *SAV/*RCL and SYST:SET commands.

B.2.9 TB MODE menu

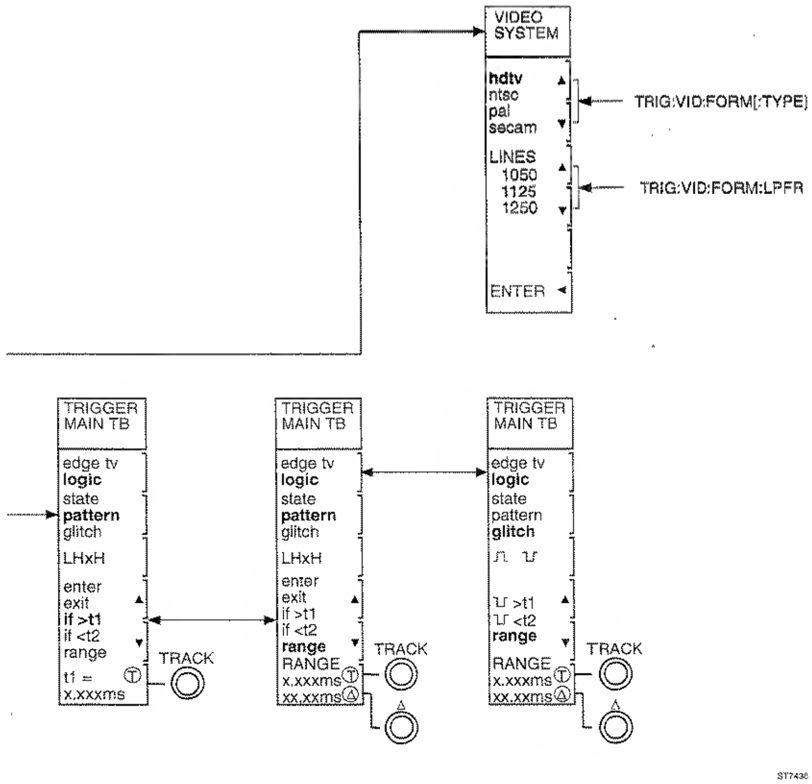


Note: - 8K points acquisition length not applicable for PM33x0A.

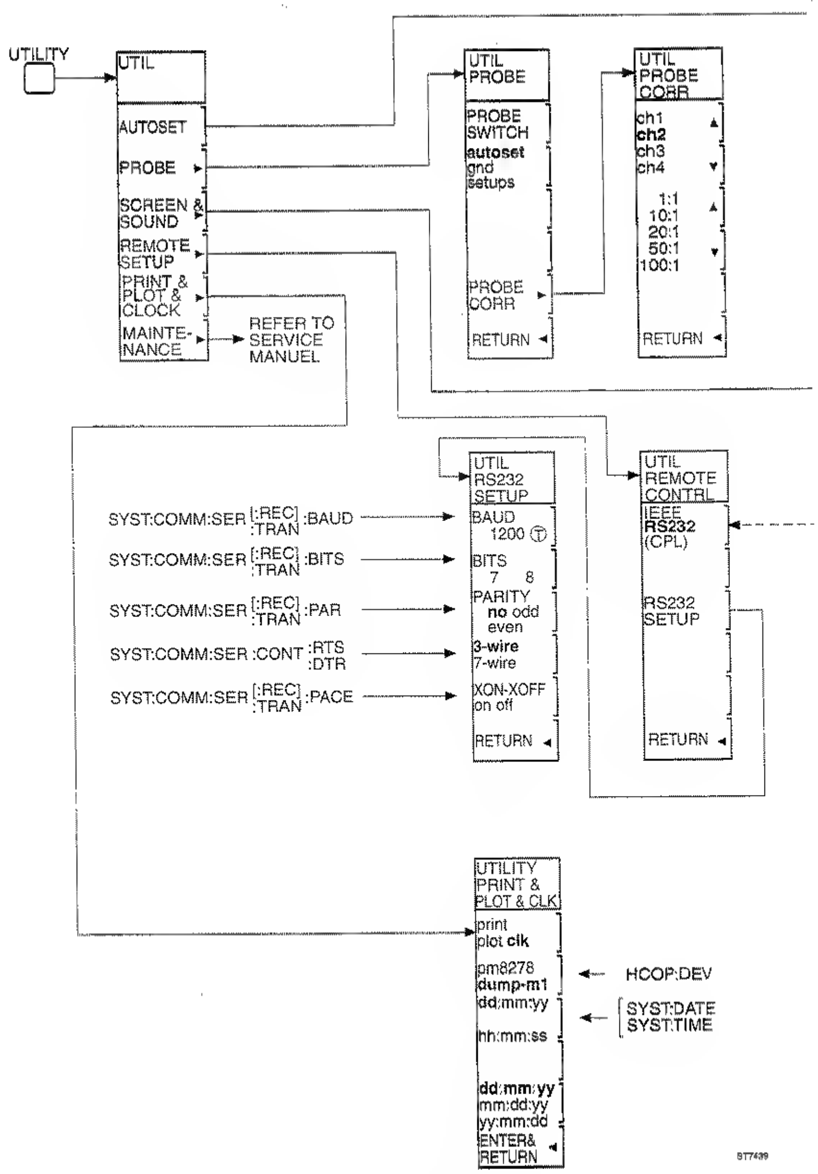
B.2.10 TRIGGER menu



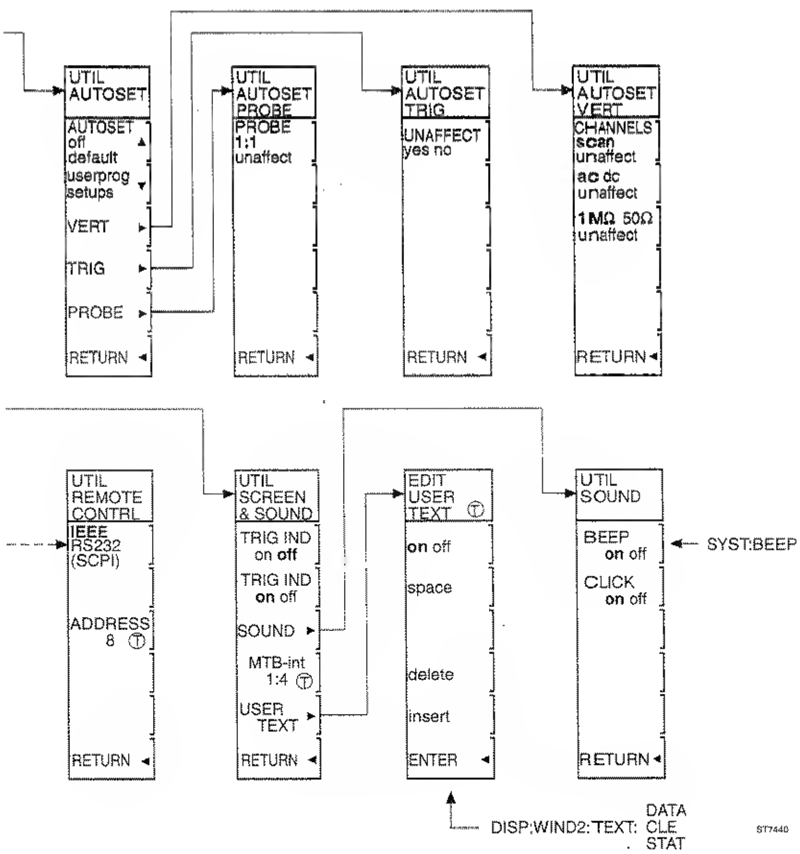
Notes:
- *ch3 is not applicable for PM33x0A.*
- *ext instead of ch4 for PM33x0A.*
- *GLITch can be programmed as trigger type (TRIGger:TYPE) instead of LOGic for PM33x0A.*


VIDEO SYSTEM
hdtv
ntsc
pal
secam
TRIG:VID:FORM[:TYPE]
LINES
1050
1125
1250
TRIG:VID:FORM:LPFR
ENTER
TRIGGER MAIN TB
edge tv
logic
state
pattern
glitch
LHxH
enter
exit
if >t1
if <t2
range
t1 =
x.xxxms
TRACK
TRIGGER MAIN TB
edge tv
logic
state
pattern
glitch
LHxH
enter
exit
if >t1
if <t2
range
RANGE
x.xxxms
xx.xxms
TRACK
TRIGGER MAIN TB
edge tv
logic
state
pattern
glitch
>t1
<t2
range
RANGE
x.xxxms
xx.xxms
TRACK
ST7438

B.2.11 UTILITY menu

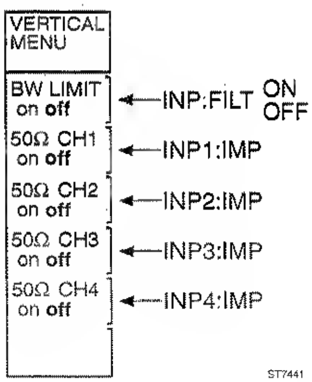


Notes: - *ch3 is not applicable for PM33x0A.*
- *ext instead of ch4 for PM33x0A.*



UTIL AUTOSET
AUTOSET off default userprog setups
VERT
TRIG
PROBE
RETURN
UTIL AUTOSET PROBE
PROBE 1:1 unaffect
RETURN
UTIL AUTOSET TRIG
UNAFFECT yes no
RETURN
UTIL AUTOSET VERT
CHANNELS scan unaffect
ac dc unaffect
1 MΩ 50Ω unaffect
RETURN
UTIL REMOTE CONTRL
IEEE RS232 (SCPI)
ADDRESS 8
RETURN
UTIL SCREEN & SOUND
TRIG IND on off
TRIG IND on off
SOUND
MTB-int 1:4
USER TEXT
RETURN
EDIT USER TEXT
on off
space
delete
insert
ENTER
UTIL SOUND
BEEP on off
CLICK on off
RETURN
SYST:BEEP
DISP:WIND2:TEXT: DATA
CLE
STAT
ST7440

B.2.12 VERTICAL menu



Note: - 50Ω/1 MΩ only applicable for PM339xA.

B.3 Cross Reference Functions / Commands

This section describes the SCPI commands that are related to the oscilloscope functions and frontpanel keys. The oscilloscope functions and keys are described in chapter 5 "Function Reference" of the Operating Guide. The SCPI commands are specified in chapter 4 "COMMAND REFERENCE" of the SCPI Programming Manual.

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
ACQUISITION LENGTH	
key TB MODE	SYSTem:KEY 409
menu TB MODE	DISPlay:MENU TBMode
- softkeys n = 1 .. 6	SYSTem:KEY n
- ACQ LENGTH	TRACe:POINts
- trace length	FORMat[:DATA]
- trace data	TRACe[:DATA]
- trace copy	TRACe:COPY
ADD INVERT SUBTRACT	
key CH1+CH2	SENSe:FUNCtion:... "XTIME:VOLTage:SUM 1,2"
key INV CH2	INPut2:POLarity
key CH3+CH4	SENSe:FUNCtion:... "XTIME:VOLTage:SUM 3,4"
key INV CH4	INPut4:POLarity
ADD (MATHEMATICS)	
key MATH	SYSTem:KEY 111
menu MATH	DISPlay:MENU MATH
- softkeys n = 1 .. 6	SYSTem:KEY n
- MATH1(2) ON/OFF	CALCulate[1|2]:MATH:STATe
- add	CALCulate[1|2]:MATH[:EXPRession]
ALT/CHOP	
key TB MODE	SYSTem:KEY 409
menu TB MODE	DISPlay:MENU TBMode
- softkeys n = 1 .. 6	SYSTem:KEY n
ANALOG MODE	INSTrument:NSELect ANALog
	INSTrument[:SELect] 2
key ANALOG	SYSTem:KEY 106
AUTO RANGE	
key AUTO RANGE (MTB)	SENSe:SWEep:TIME:AUTO
key AUTO RANGE (CH1)	SENSe:VOLTage1[:DC]:RANGe:AUTO
key AUTO RANGE (CH2)	SENSe:VOLTage2[:DC]:RANGe:AUTO
key AUTO RANGE (CH3)	SENSe:VOLTage3[:DC]:RANGe:AUTO
key AUTO RANGE (CH4)	SENSe:VOLTage4[:DC]:RANGe:AUTO

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
AUTOSET	
key AUTOSET	SYSTem:KEY 101
AUTOSET SEQUENCE	
key STATUS	SYSTem:KEY 201
key TEXT OFF	SYSTem:KEY 801
menu UTILITY → AUTOSET or PROBE	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n
AUTOSET USERPROG	
key UTILITY	SYSTem:KEY 104
menu UTILITY → AUTOSET	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n
AVERAGE	SENSe:AVERage[:STATe]
	SENSe:AVERage:TYPE?
key AVERAGE	SYSTem:KEY 507
key ACQUIRE	SYSTem:KEY 107
menu ACQUIRE	DISPlay:MENU ACQuire
- softkeys n = 1 .. 6	SYSTem:KEY n
- TRACK (select average factor)	SENSe:AVERage:COUNt
BANDWIDTH LIMITER	INPut[<n>]:FILTer[:LPASs]:FREQuency?
key VERT MENU	SYSTem:KEY 504
menu VERT MENU	DISPlay:MENU VERTical
- softkeys n = 1 .. 6	SYSTem:KEY n
- BW LIMIT	INPut[<n>]:FILTer[:LPASs][:STATe]
CALIBRATION AUTOCAL	CALibration[:ALL]
key CAL	*CAL?
CHANNEL/TRACE SELECTION	SENSe:FUNCtion ...."XTIMe:Voltage<n>"
key ON CH1	SYSTem:KEY 803
key ON CH2	SYSTem:KEY 806
key ON CH3	SYSTem:KEY 809
key ON CH4	SYSTem:KEY 812
key RECALL	SYSTem:KEY 109
menu RECALL → trace register	DISPlay:MENU RECall
- softkeys n = 1 .. 6	SYSTem:KEY n
CONFIDENCE CHECK	*TST?
CURSORS (TIME/VOLT/BOTH)	SYSTEM:SET? 32
key CURSORS	SYSTem:KEY 204
menu CURSORS	DISPlay:MENU CURSors
- softkeys n = 1 .. 6	SYSTem:KEY n

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
CURSOR READOUT	
key CURSORS	SYSTem:KEY 204
menu CURSORS	DISPlay:MENU CURSors
READOUT	DISPlay:WINDow[1]:TEXT<n>:DATA?
DELAY	SENSe:SWEep:OFFSet:TIME
menu TB MODE → EVENT DELAY	DISPlay:MENU TBMode
- softkeys n = 1 .. 6	SYSTem:KEY n
- select pos/neg slope	TRIGger:SLOPe
DELAY MEASUREMENT	
key MEASURE	SYSTem:KEY 110
menu MEASURE → MEAS1(2)	DISPlay:MENU MEASure
- softkeys n = 1 .. 6	SYSTem:KEY n
DELAYED TIMEBASE (DEL'D TB)	SYSTem:SET? 18
key DTB	SYSTem:KEY 402
key TIME/DIV s (◀)	SYSTem:KEY 403
key TIME/DIV ns (▶)	SYSTem:KEY 404
menu DTB → DEL'DTB	DISPlay:MENU DMODe
- softkeys n = 1 .. 6	SYSTem:KEY n
DIFFERENTIATE (MATHPLUS)	
key MATH	SYSTem:key 111
menu MATH	DISPlay:MENU MATH
- softkeys n=1 .. 6	SYSTem:KEY n
- MATH1(2) → differentiate ON/OFF	CALCulate[1|2]:DERivative:STATe
- PARAM → window samples	CALCulate[1|2]:DERivative:POINts
DISPLAY MENU	
key DISPLAY	SYSTem:KEY 112
menu DISPLAY	DISPlay:MENU DISPlay
- softkeys n = 1 .. 6	SYSTem:KEY n
- TEXT → USERTEXT	DISPlay:WINDow2:TEXT[1]
DIGITAL Mode	INSTrument:NSELect DIGital
	INSTrument[:SELect] 1
key ANALOG	SYSTem:KEY 106
ENVELOPE	
key ACQUIRE	SYSTem:KEY 107
menu ACQUIRE → ENVELOPE	DISPlay:MENU ACQuire
- softkeys n = 1 .. 6	SYSTem:KEY n
Error handling	see Status handling
Event handling	see Status handling

FUNCTION + KEYS/MENUS		RELATED SCPI COMMAND(S)
FFT - FAST FOURIER TRANSFORMATION (MATHPLUS)		
key MATH		SYSTem:KEY 111
menu MATH		DISPlay:MENU MATH
- softkeys n=1 .. 6		SYSTem:KEY n
- MATH1(2) → FFT ON/OFF		CALCulate[1|2]:TRANsform:FREQuency:STATE
- PARAM → select FFT windows		CALCulate[1|2]:TRANsform:FREQuency:WINDow RECTangular|HAMMing|HANNing
- read FFT amplitude/frequency		DISPlay:WINDow[1]:TEXT<n>:DATA?
- select absolute/relative FFT		CALCulate[1/2]:TRANsform:FREQuency:TYPE
FILTER (MATHEMATICS)		
key MATH		SYSTem:KEY 111
menu MATH		DISPlay:MENU MATH
- softkeys n = 1 .. 6		SYSTem:KEY n
- MATH1(2) → filter ON/OFF		CALCulate[1|2]:FILTer:FREQuency:STATe
- PARAM → window samples		CALCulate[1|2]:FILTer:FREQuency:POINts
GLITCH triggering		TRIGger:TYPE GLITch
HISTOGRAM (MATHPLUS)		
key MATH		SYSTem:KEY 111
menu MATH		DISPlay:MENU MATH
- softkeys n=1 .. 6		SYSTem:KEY n
- MATH1(2) → histogram ON/OFF		CALCulate[1|2]:TRANsform:HISTogram:STATe
HOLD OFF		TRIGger:HOLDoff
Identification		*IDN? and *OPT? SYSTem:VERSion?
INPUT ATTENUATOR		SENSe:VOLTage<n>[:DC]:RANGe:PTPeak
key AUTO RANGE channel <n>		SENSe:VOLTage<n>[:DC]:RANGe:AUTO
key AMPL CH3		SYSTem:KEY 709 (PM3392A-82A)
key AMPL CH4		SYSTem:KEY 712 (PM3392A-82A)
key AMPL mv (▲)	CH1	SYSTem:KEY 702
key AMPL v (▼)	CH1	SYSTem:KEY 802
key AMPL mv (▲)	CH2	SYSTem:KEY 705
key AMPL v (▼)	CH2	SYSTem:KEY 805
key AMPL mv (▲)	CH3	SYSTem:KEY 708 (PM3394A-84A)
key AMPL v (▼)	CH3	SYSTem:KEY 808 (PM3394A-84A)
key AMPL mv (▲)	CH4	SYSTem:KEY 711 (PM3394A-84A)
key AMPL v (▼)	CH4	SYSTem:KEY 811 (PM3394A-84A)
key AMPL	EXT (CH4)	SYSTem:KEY 712 (PM33x0A)

FUNCTION + KEYS/MENUS		RELATED SCPI COMMAND(S)
INPUT COUPLING		INPut[<n>]:COUPling AC|DC|GROund
key ON (toggled ON)		SENSe:FUNCtion
key ON CH1		SYSTem:KEY 803
key ON CH2		SYSTem:KEY 806
key ON CH3		SYSTem:KEY 809
key ON CH4		SYSTem:KEY 812
key TRIG VIEW EXT		SYSTEM:KEY 812 (PM33x0A)
key AC/DC/GND	CH1	SYSTem:KEY 804
key AC/DC/GND	CH2	SYSTem:KEY 807
key AC/DC/GND	CH3	SYSTem:KEY 810 (PM3394A-84A)
key AC/DC	CH3	SYSTem:KEY 810 (PM3392A-82A)
key AMPL	CH3	SYSTem:KEY 709 (PM3392A-82A)
key AC/DC/GND	CH4	SYSTem:KEY 813 (PM3394A-84A)
key AC/DC	CH4 (EXT)	SYSTem:KEY 813 (PM3392A-82A) (PM33x0A)
key AMPL	CH4 (EXT)	SYSTem:KEY 712 (PM3392A-82A) (PM33x0A)
INPUT IMPEDANCE		INPut[<n>]:IMPedance
key VERT MENU		SYSTem:KEY 504
menu VERT MENU		DISPlay:MENU VERTical
- 50Ω CH<n>		INPut<n>:IMPedance
INTEGRATE (MATHPLUS)		
key MATH		SYSTem:KEY 111
menu MATH		DISPlay:MENU MATH
- softkeys n=1 .. 6		SYSTem:KEY n
- MATH1(2) → integrate ON/OFF		CALCulate[1|2]:INTegral:STATe
LOGIC TRIGGER		TRIGger:TYPE LOGic
key TRIGGER		SYSTem:KEY 209
menu TRIGGER		DISPlay:MENU TRIGger
- softkeys n = 1 .. 6		SYSTem:KEY n
- TRIG slope		TRIGger:SLOPe
- TRIG source		TRIGger:SOURce
MAGNIFY HORIZONTAL		
key MAGNIFY (◄)		SYSTem:KEY 210
key MAGNIFY (►)		SYSTem:KEY 211
MAGNIFY VERTICAL		
key DISPLAY		SYSTem:KEY 112
menu DISPLAY		DISPlay:MENU DISPlay
- softkeys n = 1 .. 6		SYSTem:KEY n
MAIN TIME BASE		SENSe:SWEep:TIME
key TIME/DIV VAR s ◄		SYSTem:KEY 410
key TIME/DIV VAR ns ►		SYSTem:KEY 411
key AUTO RANGE		SENSe:SWEep:TIME:AUTO

<table>
<tr><th>FUNCTION + KEYS/MENUS</th><th>RELATED SCPI COMMAND(S)</th></tr>
<tr><td>MATHEMATICS</td><td>CALCulate[1|2]: ....</td></tr>
<tr><td>key MATH</td><td></td></tr>
<tr><td>menu MATH</td><td>DISPlay:MENU MATH</td></tr>
<tr><td>- softkeys n = 1 .. 6</td><td>SYSTem:KEY n</td></tr>
<tr><td>MEASURE MENU</td><td>MEASure?
CONFigure + READ?
CONFigure + INITiate + FETCh?</td></tr>
<tr><td>key MEASURE</td><td>SYSTem:KEY 110</td></tr>
<tr><td>menu MEASURE</td><td>DISPlay:MENU MEASure</td></tr>
<tr><td>- softkeys n = 1 .. 6</td><td>SYSTem:KEY n</td></tr>
<tr><td>- MEAS 1 & MEAS 2</td><td>DISPlay:WINDow[1]:TEXT<1|2>:DATA?</td></tr>
<tr><td>MULTIPLY (MATHEMATICS)</td><td></td></tr>
<tr><td>key MATH</td><td>SYSTem:KEY 111</td></tr>
<tr><td>menu MATH → MATH1(2)</td><td>DISPlay:MENU MATH</td></tr>
<tr><td>- softkeys n = 1 .. 6</td><td>SYSTem:KEY n</td></tr>
<tr><td>- MATH1(2) ON/OFF</td><td>CALCulate[1|2]:MATH:STATe</td></tr>
<tr><td>- multiply</td><td>CALCulate[1|2]:MATH[:EXPRession]</td></tr>
<tr><td>PASS FAIL TESTING (MATHPLUS)</td><td>*SAV, *RCL
SYSTem:SET? 51</td></tr>
<tr><td>PEAK DETECTION</td><td></td></tr>
<tr><td>key ACQUIRE</td><td>SYSTem:KEY 107</td></tr>
<tr><td>menu ACQUIRE</td><td>DISPlay:MENU ACQuire</td></tr>
<tr><td>- PEAK DET</td><td>SENSe:SWEep:PDETection</td></tr>
<tr><td>POSITION</td><td></td></tr>
<tr><td>knob POS (CH1,2,3,4)</td><td>SENSe:VOLTage[<n>][:DC]:RANGe:OFFSet</td></tr>
<tr><td>knob XPOS (CH1,2,3,4)</td><td>none</td></tr>
<tr><td>POWER SUPPLY</td><td></td></tr>
<tr><td>key POWER ON/OFF</td><td>none</td></tr>
<tr><td>PRINTING AND PLOTTING (IEEE-488.2 & RS-232)</td><td></td></tr>
<tr><td>key HARD COPY</td><td>SYSTem:KEY 113</td></tr>
<tr><td>key UTILITY</td><td>SYSTem:KEY 104</td></tr>
<tr><td>menu UTILITY → PRINT & PLOT</td><td>DISPlay:MENU UTIL</td></tr>
<tr><td>- softkeys n = 1 .. 6</td><td>SYSTem:KEY n</td></tr>
<tr><td>- get hardcopy data</td><td>HCOPy:DATA?</td></tr>
<tr><td>- real-time clock</td><td>SYSTem:DATE
SYSTem:TIME</td></tr>
<tr><td>- select hardcopy device</td><td>HCOPy:DEVice</td></tr>
</table>

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
PROBE SCALING (MATHPLUS)	*SAV, *RCL SYSTem:SET
PROBE UTILITIES key UTILITY menu UTILITY → PROBE - softkeys n = 1 .. 6	 SYSTem:KEY 104 DISPlay:MENU UTIL SYSTem:KEY n
REMOTE CONTROL IEEE-488.2 key STATUS / LOCAL key UTILITY menu UTILITY → REMOTE SETUP - softkeys n = 1 .. 6	 SYSTem:KEY 201 SYSTem:KEY 104 DISPlay:MENU UTIL SYSTem:KEY n
REMOTE CONTROL RS-232 key STATUS / LOCAL key UTILITY menu UTILITY → REMOTE SETUP - softkeys n = 1 .. 6 - RS-232 SETUP	 SYSTem:KEY 201 SYSTem:KEY 104 DISPlay:MENU UTIL SYSTem:KEY n SYSTem:COMMunicate:SERial
RUN/STOP key RUN/STOP	 SYSTem:KEY 309 INITiate:CONTinuous ON | OFF
SCREEN CONTROLS AND GRATICULE knob TRACE INTENSITY knob TEXT INTENSITY knob TRACE ROTATION knob FOCUS knob GRATICULE ILLUMINATION	 DISPlay:BRIGhtness none none none none
SCREEN MESSAGES	none
SETUPS key SETUPS menu FRONT SETUPS - softkeys n = 1 .. 6 - recall - save	 SYSTem:KEY 103 DISPlay:MENU SETups SYSTem:KEY n *RCL *SAV
SETUPS SEQUENCE key STATUS key TEXT OFF menu UTILITY - softkeys n = 1 .. 6	 SYSTem:KEY 201 SYSTem:KEY 801 DISPlay:MENU UTIL SYSTem:KEY n

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
STANDARD FRONT/FRONT PANEL RESET	SYSTem:SET *RST
key SETUPS	SYSTem:KEY 103
menu FRONT SETUPS	DISPlay:MENU SETups
- softkeys n = 1 .. 6	SYSTem:KEY n
- recall	*RCL
- save	*SAV
Status handling	*CLS *ESE, *ESR?, *SRE, *STB? STATus:OPERation[:EVENt]? STATus:OPERation:CONDition? STATus:OPERation:ENABle STATus:OPERation:PTRansition STATus:OPERation:NTRansition STATus:QUEStionable[:EVENt]? STATus:OUEStionable:CONDition? STATus:OUEStionable:ENABle STATus:QUEStionable:PTRansition STATus:OUEStionable:NTRansition STATus:OUEue[:NEXT]? STATus:PRESet SYSTem:ERRor?
STATUS SCREEN	
key STATUS / LOCAL	SYSTem:KEY 201
SUBTRACT (MATHEMATICS)	
key MATH	SYSTem:KEY 111
menu MATH	DISPlay:MENU MATH
- softkeys n = 1 .. 6	SYSTem:KEY n
- MATH1(2) ON/OFF	CALCulate[1|2]:MATH:STATe
- subtract	CALCulate[1|2]:MATH[:EXPRession]
Synchronization of controller - instruments	*OPC and *WAI
TEXT OFF	DISPlay:MENU:STATe
key TEXT OFF	SYSTem:KEY 801

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
TIMEBASE MODES	
key TB MODE	SYSTem:KEY 409
menu TB MODE	DISPlay:MENU TBMode
- softkeys n = 1 .. 6	SYSTem:KEY n
- AUTO	INITiate:CONTinuous ON TRIGger:SOURce IMMediate
- TRIG	INITiate:CONTinuous ON TRIGger:SOURce INTernal<n>
- SINGLE	INITiate[:IMMediate]
key SINGLE_ARM'D (indicator)	SYSTem:KEY 311
- MULTI	none
- ROLL	none
- REAL-TIME ONLY	SENSe:SWEep:REALtime[:STATe]
TIME MEASUREMENTS	
key MEASURE	SYSTem:KEY 110
menu MEASURE	DISPlay:MENU MEASure
- softkeys n = 1 .. 6	SYSTem:KEY n
- MEAS 1 & MEAS 2	DISPlay:WINDow[1]:TEXT<1|2>:DATA?
- frequency	MEASure:FREQuency?
- period	MEASure:PERiod?
- pulse width negative	MEASure:NWIDth?
- pulse width positive	MEASure:PWIDth?
- rise time	MEASure:RISE:TIME?
- fall time	MEASure:FALL:TIME?
- duty cycle negative	MEASure:NDUTycycle?
- duty cycle positive	MEASure:PDUTycycle?
- time of the first max value	MEASure:TMAXimum?
- time of the first min value	MEASure:TMINimum?
Note: MEASure? can be substituted by CONFigure + READ? or by CONFigure + INITiate + FETCh?	
TOUCH, HOLD & MEASURE TM	
key UTILITY	SYSTem:KEY 104
menu UTILITY → PROBE	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n
Trace handling	
- trace length (number of points)	TRACe:POINts
- trace point length	FORMat[:DATA]
- trace data	TRACe[:DATA]
- trace copy	TRACe:COPY

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
TRIGGERING OF SWEEPS	
- send GET code	*TRG
- abort trigger system	ABORt
- initiate trigger system continuously	INITiate:CONTinuous
- initiate trigger system once only	INITiate[:IMMediate]
TRIGGER COUPLING	
key TRIGGER	SYSTem:KEY 209
key DTB	SYSTem:KEY 402
menu TRIGGER	DISPlay:MENU TRIGger
menu DTB	DISPlay:MENU DMODe
- softkeys n = 1 .. 6	SYSTem:KEY n
TRIGGER DEL'D TB	
key DTB	SYSTem:KEY 402
menu DTB	DISPlay:MENU DMODe
- softkeys n = 1 .. 6	SYSTem:KEY n
TRIGGER LEVEL	
knob TRIGGER LEVEL	TRIGger:LEVel
key TRIGGER	SYSTem:KEY 409
- ac, dc, lf-reject	TRIGger:FILTer:LPASs:FREQuency TRIGger:FILTer:LPASs:STATe
- hf-reject	TRIGger:FILTer:HPASs:FREQuency TRIGger:FILTer:HPASs:STATe
key DTB	SYSTem:KEY 402
menu TRIGGER	DISPlay:MENU TRIGger
- level peak-peak	TRIGger:LEVEL:AUTO
menu DTB	DISPlay:MENU DMODe
- softkeys n = 1 .. 6	SYSTem:KEY n
TRIGGER MAIN TB	
key TRIG 1	SYSTem:KEY 604
key TRIG 2	SYSTem:KEY 607
key TRIG 3	SYSTem:KEY 610
key TRIG 4	SYSTem:KEY 613
key EXT TRIG	SYSTem:KEY 613 (PM33x0A)
key TRIGGER	SYSTem:KEY 209
menu TRIGGER	DISPlay:MENU TRIGger
- softkeys n = 1 .. 6	SYSTem:KEY n
- pos/neg trigger edge	TRIGger:SLOPe
- MAIN TB trigger source	TRIGger:SOURce

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
TV TRIGGER	TRIGger:TYPE VIDEO
key TRIGGER	SYSTem:KEY 209
menu TRIGGER	DISPlay:MENU TRIGger
- field1, field2, lines	TRIGger:VIDeo:FIELd[:NUMBer]
	TRIGger:VIDeo:FIELd:SELect
- select line number (TRACK)	TRIGger:VIDeo:LINE
- pos/neg signal polarity	TRIGger:VIDeo:SSIGnal
- VIDEO SYSTEM	TRIGger:VIDeo:FORMat[:TYPE]
	TRIGger:VIDeo:FORMat[:TYPE]:LPFRame
USERTEXT	DISPlay:WINDow2:TEXT:CLEar
	DISPlay:WINDow2:TEXT:DATA
	DISPlay:WINDow2:TEXT:STATe
key UTILITY	SYSTem:KEY 104
menu UTILITY → USER TEXT	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n
UTIL MAINTENANCE	CALibration[:ALL]?
key CAL	*CAL?
UTIL MENU	
key UTILITY	SYSTem:KEY 104
menu UTILITY	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n
UTIL SCREEN & SOUND	SYSTem:BEEPer
	SYSTem:BEEPe:rSTATe
key UTILITY	SYSTem:KEY 104
menu UTILITY → SCREEN & SOUND	DISPlay:MENU UTIL
- softkeys n = 1 .. 6	SYSTem:KEY n

FUNCTION + KEYS/MENUS	RELATED SCPI COMMAND(S)
VOLT MEASUREMENTS	
key MEASURE	SYSTem:KEY 110
menu MEASURE	DISPlay:MENU MEASure
- softkeys n = 1 .. 6	SYSTem:KEY n
- MEAS 1 & MEAS 2	DISPlay:WINDow[1]:TEXT<1|2>:DATA?
- dc voltage	MEASure[:DC]?
- rms voltage	MEASure:AC?
- amplitude voltage	MEASure:AMPLitude?
- max voltage	MEASure:MAXimum?
- min voltage	MEASure:MINimum?
- peak-to-peak voltage	MEASure:PTPeak?
- high level voltage	MEASure:HIGH?
- low level voltage	MEASure:LOW?
- falling overshoot voltage	MEASure:FALL:OVERshoot?
- falling preshoot voltage	MEASure:FALL:PREShoot?
- rising overshoot voltage	MEASure:RISE:OVERshoot?
- rising preshoot voltage	MEASure:RISE:PREShoot?
Note: MEASure? can be substituted by CONFigure + READ? or by CONFigure + INITiate + FETCh?	
X-DEFLECTION (X-DEFL, X vs Y)	
key DISPLAY	SYSTem:KEY 209
menu DISPLAY	DISPlay:MENU DISPlay
- softkeys n = 1 .. 6	SYSTem:KEY n

Notes: The functions, keys, menus, and related SCPI commands for the PM33x0A CombiScope instruments are:

- *not applicable for channel 3.*
- *partly available for channel 4 as external trigger input.*

APPENDIX C MANUAL CONVENTIONS

C.1 Abbreviations Used

ABBREVIATIONS USED (in alphabetical order)

- ADC = Analog to Digital Convertor
- AH = Acceptor Handshake
- ANSI = American National Standards Institute
- ASCII = American Standard Code for Information Interchange

- C = Controller
- CAL = Calibration
- CLS = Clear Status
- CME = Command Error
- CR = Carriage Return

- <dab> = data byte
- DC(L) = Device Clear
- DDE = Device Dependent Error
- dec = decimal
- DSO = Digital Storage Oscilloscope
- DT = Device Trigger

- EBNF = Extended Backus Nauer Format
- e.g., = exempli gratia (for example)
- EOI = End Or Identify
- EOL = End Of Line
- ESB = Event Status Bit
- ESC = Escape
- ESE = Event Status Enable
- ESR = Event Status Register
- EXT = External

- FIFO = First In First Out

- GET = Group Execute Trigger
- GL = Go to Local
- GTL = Go To Local
- GP = General Purpose
- GPIB = General Purpose Interface Bus
- GR = Go to Remote

- HDTV = High Definition Television
- Hex = Hexadecimal
- HPGL = Hewlett Packard Graphics Language

- IDY = Identify
- IDN = Identification
- IEC = International Electrotechnical Commission
- IEEE = Institute of Electrical and Electronic Engineers
- i.e. = Id est (that is)
- IFC = Interface Clear
- INT = Internal
- I/O = Input/Output
- ISO = International Standards Organization

- L = Listener
- LF = Line Feed
- LLO = Local Lockout
- LO = Listen Only

- MAX = Maximum
- MAV = Message Available
- MIN = Minimum
- MLA = My Listen Address
- MSS = Master Summary Status
- MTA = My Talk Address
- MTB = Main Time Base

- NL = New Line (equal to LF)
- NRf = Numeric format
- NTF = Negative Transition Filter
- NTR = Negative Transition Register
- NTSC = National Television System Committee

- OPC = Operation Complete
- OPER = Operation
- OPT = Optional
- OSC = Oscilloscope

- PAL = Phase Alternating Line
- phs = program header separator
- pmt = program messaga terminator
- pmu = program message unit
- PON = Power ON
- PP = Parallal Poll
- PTF = Positive Transition Filter
- PTR = Positiva Transition Ragister

- QUES = Questionabla

- RAM = Random Access Memory
- RCL = Recall
- REN = Remote Enable
- RL = Remote Local
- rms = root mean squere
- rmt = response message terminetor
- rmu = response messege unit
- RQC = Request Control
- RQS = Request Service
- RST = Reset
- rtl = return to local

- SAV = Save
- SCPI = Standard Commands for Programmable Instruments
- SDC = Selected Device Clear
- SECAM = Sequentielle Couleurs à Mémoire
- SH = Source Handshake
- SPD = Serial Poll Disable
- SPE = Serial Poll Enable
- SRE = Service Request Enable
- SR(Q) = Service Request
- STB = Status Byte
- Std = Standard

- T = Talker
- T&M = Test & Measurement
- TRG = Trigger
- TST = Test
- TTL = Transistor-Transistor Logic

- UNL = Unlisten
- UNT = Untalk
- URQ = User Request
- WAI = Wait to continue

C.2 Glossary of Symbols Used

- µV	=	micro voltage (1E-6)
- dB	=	decibell
- dBm	=	decibell with respect to 1 mW
- dBµV	=	decibell with respect to 1 µV
- Vrms	=	RMS voltage (Peak /√2)
- Hz	=	Hertz
- m	=	meter
- Mbyte	=	Megabyte
- ms	=	milliseconds
- mw	=	milliwatt (1E-3)
- s	=	seconds
-%	=	percentage
- [...]	=	Default program message part, which can be optionally specified. This means that a program message may or may not contain the defaulted keyword, without changing the semantic meaning of the message.
- { ... }	=	Program message part that can be repeated (zero or more times).
- |	=	sign to indicate a choice (... or ...)
- ^	=	Ctrl key, E.g.,, ^END means Ctrl + END
- ⊕	=	'logical OR' symbol (... or ...)
- Ⓐ (&)	=	'logical AND' symbol (... and ...)

C.3 List of Tables

C.4 List of Figures

C.5 Documents Referenced

1) General Purpose Interface Bus (GPIB)
   IEC 625-1 / IEEE-488.1

   Order number: 4822 872 80193
2) SCPI - Standard Commands for Programmable Instruments

   Order number: 4822 872 80194
3) SCPI in the German language

   (Standard Kommandos für Programmierbare Instrumenten)

   Order number: 4822 872 80174
4) SCPI in the French language

   (Commandes Standard pour Instruments Programmables)

   Order number: 4822 872 80175

APPENDIX D
STANDARDS INFORMATION

D.1 SCPI Conformance Information

All commands comply to the SCPI standard 1994.0, except for the following:

- The *RST condition of the SENSe:VOLTage<n>[:DC]:RANGe:AUTO ON | OFF command.

  Exception: After *RST, autoranging MTB is switched off.

- The *RST condition of the SENSe:SWEep:TIME:AUTO ON | OFF command.

  Exception: After *RST, autoranging attenuators CH1, CH2, CH3, and CH4 are switched off.

- The <device> parameter of the HCOPy:DEVice <type> command.

  Exception: The HCOPy:DEVice command allows to select the hardcopy device by specifying its name or type number, e.g., <type> = HPLASER or LO1500.

In addition, the following commands are implemented:

- The CALCulate:TRANsform:FREQuency:TYPE ABSolute | RELative command.

  Purpose: To allow the selection of absolute or relative FFT calculation.

- The TRIGger[:SEQuence[1] | STARt]:VIDeo:FORMat[:TYPE] <type> command.

  Purpose: To allow the selection of a TV standard by specifying its name or abbreviation, e.g., <type> = HDTV.

- The SYSTem:SET? <node_number> query.

  Purpose: To allow the instrument settings to be saved and restored in functional groups (nodes) as specified by the <node_number>.

D.2 List of Implemented IEEE-488.2 Syntactical Elements

The following list of elements is used in the common end SCPI commends:

<PROGRAM MESSAGE>
Represents a sequence of zero or more <PROGRAM MESSAGE UNIT> elements, separated by <PROGRAM MESSAGE UNIT SEPARATOR> ELEMENTS.

<PROGRAM MESSAGE UNIT>
Represents a single command, programming data, or a single query received by a device.

<COMMAND MESSAGE UNIT>
Represents a single command or programming data received by a device.

<OUERY MESSAGE UNIT>
Represents a single query sent form the controller to a device.

<PROGRAM DATA>
A program data element is also referred to as a parameter. It represents any of the following data types:

<CHARACTER PROGRAM DATA>
A data type suitable for sending short mnemonic data, generally where a numeric data type is not suitable. Refer to <character_data> of section 4.1.2 "Data types".

<DECIMAL NUMERIC PROGRAM DATA>
A data type suitable for sending decimal integers or fractions with or without exponents. Refer to <numeric_data> of section 4.1.2 "Data types".

<NON-DECIMAL NUMERIC PROGRAM DATA>
A data type suitable for sending integer numeric representations in base 16 (hexadecimal), 8 (octal), or 2 (binary). Refer to <numeric_data> of section 4.1.2 "Data types".

<STRING PROGRAM DATA>
A data type suitable for sending 7-bit ASCII character strings. Refer to <string_data> of section 4.1.2 "Data types".

<ARBITRARY BLOCK PROGRAM DATA>
A data type suitable for sending blocks of erbitrary 8-bit data bytes. Refer to <block_data> of section 4.1.2 "Data types".

<EXPRESSION PROGRAM DATA>
Represents an expression between parentheses.
Exemple: (CH1-CH2).

<PROGRAM MESSAGE UNIT SEPARATOR>
Saparates the <PROGRAM MESSAGE UNIT> elements from one another in a <PROGRAM MESSAGE>. Only the semicolon (;) is allowad as program message unit separator.

<PROGRAM DATA SEPARATOR>
Saparatas sequential <PROGRAM DATA> alements that ara related to tha same command program headar. Only the colon (,) is allowed as program data separator.

<PROGRAM HEADER SEPARATOR>
Separates the command program header from any associated <PROGRAM DATA>. Any one of the "white space" characters (decimal 0 to 9 or 1 to 32) is allowed.

<PROGRAM MESSAGE TERMINATOR>
Terminates a <PROGRAM MESSAGE>. The following combinations are allowed:

- NL^END — This is the NewLine code (decimal 10) sent concurrently with the END message on the GPIB.
- NL — This is the NewLine code (decimal 10).
- <dab>^END — This is the END message concurrently sent with the last data byte (<dab>).

<COMMAND PROGRAM HEADER>
Specifies a function or operation. Used with any associated <PROGRAM DATA> element.

<OUERY PROGRAM HEADER>
Similar to <COMMAND PROGRAM HEADER>, except the query indicator (?) at the end shows that a response is expected from the device.

APPENDIX E
SUMMARY OF SYSTEM SETTINGS

The following table identifies which instrument settings belong to which node.

NODE NR:	SPECIFICATION:
0	*End node settings* length = 1 byte zero
1 | 2 | 3 | 4	*Channel 1/2/3/4 settings* length = 8 bytes attenuation, channel on/off, input coupling DC/AC/grounded, invert on/off, input impedance 50Ω/1MΩ, attenuation mode continuous/discrete, Y_offset_position.
14	*Probe scale settings* length = 24 bytes probe_correction_factors CH1/2/3/4, probe_scale bits, probe_unit CH1/2/3/4, probe_scale_factors CH1/2/3/4.
15	*Common vertical settings* length = 6 bytes add CH1+CH2, add CH3+CH4, display mode alternate/chopped, automatic display on/off, bandwidth limiter on/off, averaging on/off, envelope mode on/off, averaging factor, vertical magnify factor.
16	*Horizontal settings* length = 9 bytes x-deflection on/off, reset on/off, acquisition lock on/off, scope mode digital/analog, peak detection on/off, horizontal mode: auto, triggered, single-shot, multiple-shot, x-deflection source CH1/2/3/4/line, digital magnify factor + analog magnify on/off, acquisition length factor, x-position.
17	*Main timebase settings* length = 26 bytes timebase, trigger mode: edge, TV, pattern, state, glitch, intensified on/off, main timebase on/off, trigger slope pos/neg, TV trig mode field1/field2/line, noise suppression on/off, mtb mode continuous (var. steps)/discrete (1-2-5 steps), peak-peak trig on/off, triggered on/off, armed on/off, Vpp trig slope, roll mode stop on trig/continuous, autoset trigger gap on/off, roll mode on/off, real-time only on/off, dual slope triggering on/off, trigger level, trigger source CH1/2/3/4, composite, line, external, trigger delay value, trigger coupling AC, DC, LF reject, HF reject, TV-system PAL, HDTV, NTSC, SECAM, pattern glitch condition ENTER, EXIT, RANGE, >T1, <T2, trigger pattern CH1/2/3/4, TV line number, pattern/glitch trigger time T1/2.

18	*Delayed timebase settings* delayed timebase, trigger mode edge, TV, trigger level, delayed timebase on/off, trigger slope pos/neg, noise suppression on/off, trigger source CH1/2/3/4, mtb, trigger delay, trigger coupling AC, DC, LF reject, HF reject.	length = 13 bytes
19	*Event trigger delay* settings event counter, event trigger level, event trigger source CH1/2/3/4, event triggering on/off, event trigger slope pos/neg, event trigger coupling AC, DC.	length = 9 bytes
20	*SCPI trigger source* SCPI_trigger_source IEEE-bus, Immediate, CH1/2/3/4.	length = 4 bytes
32	*Cursor settings* voltage/time cursors on/off, rise time on/off, cursor control volt/time, Vpp on/off, rise time 10-90%/20-80%, voltage readout Vpp/Vp-Vp+, readout on/off: delta-V, absolute V1&V2, voltage ratio, delta-T, 1/delta-T, time ratio, time phase, Vdc, X cursor 1/2, Y cursor 1/2, X/Y ratio, cursor source CH1/2/3/4, track & delta control, ref. & delta control, degrees cursors horizontal and vertical selection, V1&V2 readout, dBm/dBμV/ Vrms readout, FFT ref. impedance 50Ω/600Ω, digital source cursor 1/2 CHn, Mi_j, magnify factor delta-X/Y ratio.	length = 33 bytes
33	*Cursor autosearch settings* autosearch cursors on/off, edge1/2, cursor display reference, absolute/relative readout, Cas_level cursor 1/2, Cas_reference cursor 1/2 min, max, low, high, gnd, abs, Cas_upper/lower_level cursor 1/2.	length = 18 bytes
49 I 50	*MEASurement 1/2 settings* measurement on/off, slope first + second source pos/neg, measure type dc, rms, peak-up, peak-down, peak-to-peak, histogram top, histogram bottom, overshoot, preshoot, delay, frequency, period, pulse, rise time, fall time, duty cycle, MEAS1/2 source CHn, Mi_j, bytes 9+10 not used (only applicable for MEAS1).	length = 10/8 bytes
51	*Pass/Fail test settings* Pft on/off, envelope, meas1, meas2, cursor, no action, beep, stop, save source at fail, start hardcopy at fail, draw upper/lower range, Pft cursor define, Pft test range type, delta_V, V1, delta-T, 1/delta-T, greater than, lower than, range test, Pft_source/destination/save_register, Pft_higher/lower_limit, Pft_vertical/horizontal_draw_position.	length = 20 bytes

65 | 66	*MATH1/2 settings* MATH1/2 selection, limited on/off, FFT filter Hemming/Hanning/Rectengle, adjustify scale/offset, source1/source2, Y-cursors/X-cursors, mathematics type edd, subtrect, multiply, filter, integrate, differentiate, fest fourier, histogram, source MATH1/2 CHn, Mi_j, scele, offset, filter window width, differentiate window width, FFT eree left/right border, Y-offset integrete limited area, FFT absolute/reletive readout.	length = 22 bytes
80	*Display settings* settings display on/off, ground and trigger level indication on/off, dots join on/off, X versus Y on/off, status view on/off, window on/off, menu number, menu on/off, hold-off time, trace separation, X source (X versus Y mode), display_trace definition 1 to 8, sine wave interpolation on/off.	length = 27 bytes
81	*Trace intensity settings* analog trace intensity, mtb/dtb intensity ratio.	length = 5 bytes
82	*Display trace position settings* display_y_pos trace 1 to 8, display_x_pos trace 1 to 8.	length = 34 bytes
96	*Setup label text (22 characters)* setup label text characters.	length = 24 bytes
112	*Autorange settings* auto time base on/off, auto attenuation CH1/2/3/4 on/off, degrees mode on/off, 4-stroke/normal mode, auto time base degrees/time factors.	length = 8 bytes
128	*Real-time clock settings* clock format selection.	length = 3 bytes
240	*Service (factory) settings* auto/manual_cal adjustments.	length = 5 bytes

Numerics

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